165-153 B AU 3407 49411

EP 000625686 A2
NOV 1994

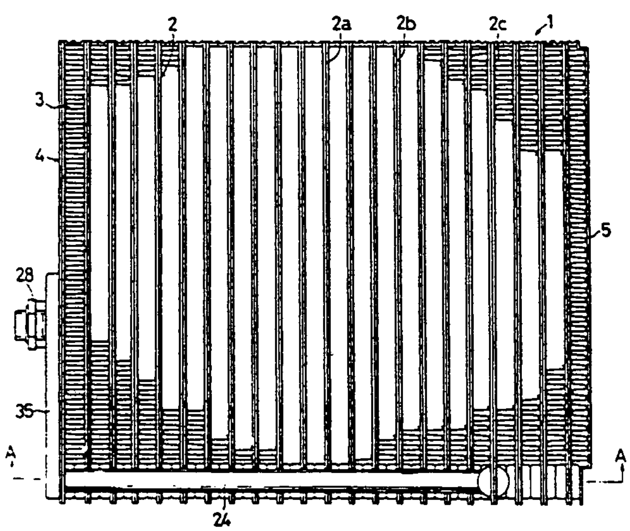
★DIES Q78 94-359825/45 ★EP 625686-A2
Laminated heat exchanger for vehicle air-condition systems - has elements bonded together with laminated fins and coolant tanks on each side (Eng)

ZEXEL CORP 93.12.02 93JP-338824 (93.05.20 93JP-141460)
(94.11.23) F28D 1/03
94.05.19 94EP-303596 R(DE ES FR GB SE)

Heat exchanging elements are made up of bonded plates which face each other which are alternately laminated with corrugated fins. A coolant has tanks that are adjacent in each other in direction of lamination on one side. The tanks on the other side communicate with each other and form tank groups.

Layers of routes are formed with one of the tank groups on one side having U-shaped passage that communicates with the passage. Specific tank groups are adjacent to each ther in the direction of the lamination and are in communication with each other. Inlet/outlet passage forming plate is bonded onto the end plates and provided with an entrance/exit section onto which expansion valve is mounted. Coolant passages are in communication with exit/entrance sections, and communicating pipe is bonded to communicates with the second passage.

ADVANTAGE - Provides space saving and realises an improvement in heat exchanging capability. (36pp Dwg.No.1/27B)
N94-281927



US Pat No 5,553,664

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 625 686 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94303596.4**

(51) Int. Cl.^{5}: **F28D 1/03**

(22) Date of filing: **19.05.94**

(30) Priority: **20.05.93 JP 141460/93**
02.12.93 JP 338824/93

(43) Date of publication of application:
23.11.94 Bulletin 94/47

(84) Designated Contracting States:
DE ES FR GB SE

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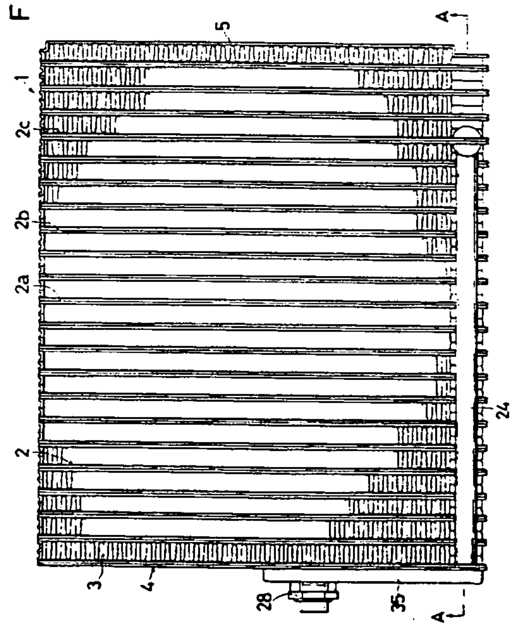
(54) Laminated heat exchanger.

(57) The objects of the present invention are to facilitate the mounting of the expansion valve by achieving a simple structure, to achieve space saving and to achieve an improvement in the heat exchanging capacity with a structure in which the intake / outlet passage forming plate that is provided with an entrance / exit section onto which the expansion valve is mounted, a first coolant passage that communicates between one side of the intake / outlet section and one end of the coolant path and a second coolant passage that connects the other side of the intake / outlet section and the other end of the coolant path via a communicating pipe, is bonded into one of the end plates. With this structure, the shapes of the first and second coolant passages in the intake / outlet passage forming plate can be changed, making it possible to have the entrance / exit section, onto which the expansion valve is mounted, communicate freely with the outflow / inflow sides of the coolant path. Also, by providing a plurality of tanks, to communicate between the communicating pipe and the tank groups at one end of the coolant path and, by changing the communicating positions, improve the heat exchanging capacity.

FIG. 1



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The present invention relates to a laminated heat exchanger that is used for automotive air conditioning systems, in particular, a laminated heat exchanger which is structured by laminating a plurality of heat exchanging elements, each of which is provided with a pair of tanks that communicate with each other through a U-shaped passage, together with a plurality of corrugated fins.

In recent years, depending upon the layout of the engine compartment of the vehicle, it is often the case that positioning the entry pipe or the expansion valve at the tank in the lower section of the heat exchanger creates a hindrance. To deal with this problem, the entry pipe is not normally led out at the end plate side of the heat exchanger, rather, it is led out at the front of the heat exchanger and the piping is implemented at a specific height by leading the pipe around.

However, with this method, the problem of reduced cooling capacity is likely to arise, as the ventilating resistance is increased by the entry pipe, the expansion valve which is connected to the entry pipe, and the like. In order to eliminate this problem, the heat exchanger disclosed in Japanese Patent Unexamined Publication 3-170755 has an entry pipe located on the surface on the side.

This example makes it possible to provide an entry pipe on one side by forming a central tank group or a pipe between a pair of tanks when structuring a coolant path with four or more routes.

However, in the example described above, since the pitch of the entrance to the expansion valve and the pitch of the heat exchanger entrance do not match, a space for mounting the expansion valve is required. Also, as it is necessary to maneuver the entry pipe to this space, no space saving can be realized. Another problem is that the number of components increases.

The object of the present invention is to provide a laminated heat exchanger with a simple structure which facilitates the mounting of an expansion valve so as to achieve space saving and which also realizes an improvement in heat exchanging capability.

In order to achieve this object, the present invention is provided with a plurality of heat exchanging elements, each of which is provided with a pair of tanks and a U-shaped passage that communicate between the two tanks. These heat exchanging elements are laminated alternately with a plurality of corrugated fins. End plates are provided at both ends in the direction of the lamination, and U-shaped passages that communicate between the tanks of the various adjacent heat exchanging elements are formed as necessary to communicate between one tank group and another tank group in such a way that these groups of tanks are partitioned to form a coolant path with a plurality of routes. The laminated heat exchanger is further provided with an entrance / exit section to which an expansion valve is mounted and which is bonded onto one of the aforementioned end plates; an intake / outlet passage that is formed in one of the aforementioned end plates and is provided with a first coolant passage that communicates with the tank group at one end of the aforementioned coolant path and one side of the aforementioned entrance / exit section, a second coolant passage that communicates with the other side of the aforementioned entrance / exit section and a pipe insertion hole that is formed in one of the aforementioned end plates, and a communicating pipe, one end of which communicates with the aforementioned second coolant passage by being bonded to the aforementioned pipe insertion hole and the other end of which communicates with the tank group at the other end of the aforementioned coolant path.

Therefore, according to the present invention, since the entrance / exit section onto which the expansion valve is mounted, and the intake / outlet passage forming plate that is provided with the first coolant passage that communicates between one side of the entrance / exit section and one end of the coolant path, and the second coolant passage that is connected to the other side of the aforementioned entrance / exit section and the other end of the coolant path via the communicating pipe are both bonded to one of the end plates, the entrance / exit section onto which the expansion valve is mounted and the inflow / outflow sides of the coolant path can be made to communicate freely by varying the form of the first and second coolant passages in the intake / outlet passage forming plate.

Also, in the present invention, the aforementioned communicating pipe may be provided at the side of the aforementioned tank groups. One end of this pipe communicates with the first pipe insertion hole, which is formed in the extended portion that extends to one side from the lower section of the end plate and the intake / outlet passage forming plate which is bonded onto this end plate. This pipe insertion hole, in turn, communicates with the second coolant passage. The other end of the communicating pipe communicates with the second pipe insertion hole which is formed in the extended portion that extends to one side from a specific tank in the tank group which is positioned at the other end of the aforementioned coolant path. Alternately, this communicating pipe may be provided in a pipe insertion groove which is formed between the aforementioned one tank group and the other tank group, with one end communicating with the first pipe insertion hole that is formed at the center of the lower area of the aforementioned end plate and the intake / outlet passage forming plate which is bonded on to the end plate and which communicates with the second cooling path, the other end communicating with the second pipe insertion hole that is formed at the center of the lower area of the other end plate and, at the same time, with

a by-pass being formed in the aforementioned other end plate to communicate between the second pipe insertion hole and the end of the tank group which is at the other end of the aforementioned coolant path.

As a result, since the aforementioned communicating pipe is provided at the side of the tank group or, alternately, a pipe insertion groove is formed between one tank group and the other to accommodate the aforementioned communicating pipe, the necessity for leading the pipe through the area where heat exchanging is performed in the heat exchanger is eliminated.

Also, in the present invention, the aforementioned communicating pipe may be provided in the pipe insertion groove which is formed between the aforementioned one tank group and the other tank group, with one end communicating with the first pipe insertion hole, which is formed at the center of the lower area of the aforementioned end plate and the intake / outlet passage forming plate which is bonded onto the end plate and which communicates with the aforementioned second coolant passage, the other end communicating astride the extended portions which extend to the side of the pipe insertion groove from at least two tanks that do not lie adjacent to each other in the tank group at the other end of the aforementioned coolant path.

Furthermore, the aforementioned communicating pipe may be provided in the pipe insertion groove which is formed between the aforementioned one tank group and the other tank group, one end communicating with the first pipe insertion hole that is formed at the center of the lower area of the aforementioned end plate and the intake / outlet passage forming plate which is bonded onto the end plate and which communicates with the aforementioned second coolant passage, the other end communicating with the extended portion which extends to the side of the pipe insertion groove from the tank that is positioned at a specific position towards the outside from the center of the tank group which is at the other end of the aforementioned coolant path.

Yet again, the aforementioned communicating pipe may be provided in the pipe insertion groove which is formed between the aforementioned one tank group and the other tank group, one end communicating with the first pipe insertion hole, which is formed at the center of the lower area of the aforementioned end plate and the intake / outlet passage forming plate which is bonded onto the end plate and which communicates with the aforementioned second coolant passage, and the other end of which communicates with the extended portion that extends to the side of the pipe insertion groove from a tank which is one of the tanks in the tank group at the other end of the aforementioned coolant path and which is structured with at least two continuous formed plates.

Therefore, it is possible to achieve an improvement in the flow of the coolant from the communicating pipe to the tank group or from the tank group to the communicating pipe as well as an improvement in the temperature distribution because the other end of the aforementioned communicating pipe communicates astride the extended portions that extend toward the pipe insertion groove from at least two tanks which are not adjacent to each other in the tank group that is at the other end of the aforementioned coolant path. The other end of the aforementioned communicating pipe communicates with the extended portion that extends toward the pipe insertion groove from the tank that is positioned at a specific position toward the outside from the center of the tank group at the other end of the aforementioned coolant path. Or, the other end of the aforementioned communicating pipe communicates with the extended portion that extends toward the pipe insertion groove from the tank that is one of the tanks in the tank group at the other end of the aforementioned coolant path and which is structured with at least two continuous formed plates.

Many other advantages, features and objects of the present invention will be understood by those of ordinary skill in the art by referring to the attached drawings, which illustrate preferred embodiments of the present invention, in which:

Figure 1 is a front elevation of the laminated heat exchanger in the first embodiment;

Figure 2 is a side elevation of the laminated heat exchanger in the first embodiment;

Figure 3 is a cross section through the line A - A of the laminated heat exchanger in Figure 1;

Figure 4 is an exploded perspective of the area of the end plate in the first embodiment;

Figure 5 is an exploded perspective of the heat exchanging element into which the communicating pipe is inserted;

Figure 6 is an exploded perspective of the communicating pipe in another embodiment;

Figure 7 is a front elevation of the laminated heat exchanger in the second embodiment;

Figure 8 is a front elevation of the laminated heat exchanger in the third embodiment;

Figure 9 is a perspective of the heat exchanging element in the third embodiment, into which the communicating pipe is inserted;

Figure 10 is a exploded perspective of the communicating pipe in the third embodiment;

Figure 11 is a front elevation of the laminated heat exchanger in the fourth embodiment;

Figure 12 is a side elevation of the laminated heat exchanger in the fourth embodiment;

Figure 13 is a bottom view of the laminated heat exchanger in the fourth embodiment;

Figure 14 is a exploded perspective in the area of the end plate in the fourth embodiment;

Figure 15 is a bottom view of the laminated heat exchanger in the fifth embodiment;

Figure 16 is an enlarged partial cross section of the laminated heat exchanger in the fifth embodiment;

Figure 17 is an enlarged partial cross section of the laminated heat exchanger featuring another communicating pipe in the fifth embodiment;

Figure 18 is a bottom view of the laminated heat exchanger in the sixth embodiment;

Figure 19 is an enlarged partial cross section of the laminated heat exchanger in the sixth embodiment;

Figure 20 is a bottom view of the laminated heat exchanger in the seventh embodiment;

Figure 21 is an enlarged partial cross section of the laminated heat exchanger in the seventh embodiment;

Figure 22 is a bottom view of the laminated heat exchanger in the eighth embodiment;

Figure 23 is an enlarged partial cross section of the laminated heat exchanger in the eighth embodiment;

Figure 24 is a bottom view of the laminated heat exchanger in the ninth embodiment;

Figure 25 is an explanatory diagram showing the temperature distribution of the laminated heat exchanger in the ninth embodiment;

Figure 26 (a) is a partial cross section illustrating the bonding of the communicating pipe and the first pipe insertion hole;

Figure 26 (b) is a partial cross section illustrating the bonding of the communicating pipe and the second pipe insertion hole;

Figure 27 (a) is a partial cross section showing the end plate side;

Figure 27 (b) is a partial cross section showing the heat exchanging element side of the communicating pipe, both ends of which are provided with a guide.

The following is an explanation of the embodiments of the present invention in reference to the drawings.

The laminated heat exchanger 1 (hereafter referred to as "heat exchanger") which is disclosed in the first embodiment as shown in Figures 1 - 5 may be a heat exchanger with, for example, 6 routes and it is assembled by laminating the heat exchanging elements 2 and corrugated fins 3 alternately with the end plates 4, 5 provided at both sides in the direction of the lamination, with the assembled structure being brazed as a unit in the furnace.

The heat exchanging elements 2 (2a, 2b, 2c) are structured by joining formed plates facing each other and in this embodiment, they are structured with four different types of formed plates, that is, formed plates 6, 7, 8 and 9.

The formed plate 6 is provided with two indented portions 10, 11 which are formed by distending the lower portion thereof, as shown in Figure 4 and is also provided with the elongated raised member 12 which separates the two indented portions 10, 11 and which extends upwards. Around the peripheral edge of the elongated raised member 12, a U-shaped groove 13, that communicates between the aforementioned indented portions 10, 11 is formed. Also, the opening portions 14, 15 are formed in the aforementioned indented portions 10, 11 respectively. The formed plate 7 has only one of the opening portions 14, 15 (for example, the opening portion15) actually open.

The heat exchanging element 2a is formed by bonding the formed plates 6, 6 facing each other. Within the heat exchanging element 2a, the tanks 16, 17 shown in Figure 3 are formed by the indented portions 10, 11 which face each other and the U-shaped passage 18 is formed by the two U-shaped grooves 13. With the heat exchanging elements 2a, the tanks which are in contact with each other among the adjacent heat exchanging elements communicate with each other.

The heat exchanging element 2b is formed by bonding the aforementioned formed plates 6, 7 facing each other. The whole structure is built so that the heat exchanging elements 2b and the aforementioned heat exchanging elements 2a communicate between the adjacent tanks on one side while the tanks on the other side are blocked off from each other.

The heat exchanging element 2c is formed by bonding the formed plates 8, 9 facing each other, as shown in Figure 5. The formed plate 8 has its lower portion distended to form the indented portions 10, 19. The indented portion 19, in particular, is formed in such a manner that it extends over a specific width to the side from the heat exchanging elements 2a, 2b. It has an opening portion 20 formed in a position that corresponds to that of the aforementioned opening portions 14, 15. Also, the formed plate 9 has a shape that is symmetrical to the formed plate 8 so that it can form the heat exchanging element 2c when bonded with the aforementioned formed plate 8. In the indented portion 21 which is formed in the formed plate 9 at a position that corresponds to that of the aforementioned indented portion 19, the opening portion 22 is formed at a position that correspond to that of the aforementioned opening portions 14, 15 and to its side, a pipe insertion hole 23 (second pipe insertion hole) is formed, into which one end of the communicating pipe 24 is inserted.

The heat exchanging elements 2 (2a, 2b ,2c) which are formed by the formed plates 6, 7, 8, 9 as described above are laminated while clamping the corrugated fins 3, and at both ends in the direction of the lamination, end plates 4, 5 are provided.

The end plate 4 is structured with a flat plate 4a and the intake / outlet passage forming plate 4b and the flat plate 4a blocks off the formed plate 6 which is positioned at the end of the heat exchanging ele-

ment group to form the heat exchanging elements at the far end. In this flat plate 4a, a coolant intake hole 25 which opens into the indented portion 10 of the formed plate 6, the flange portion 26 which extends out in the form of a semi circle at a position corresponding to that of the extension of the aforementioned indented portion 19 and the pipe insertion hole (first pipe insertion hole) 27 which is formed in the flange portion 26 for fitting the communicating pipe 24, are formed.

The intake / outlet passage forming plate 4b is bonded to the flat plate 4a by brazing or the like to form the end plate 4, which is comprised of: the flange portion 34 which corresponds to the aforementioned flange portion 26, the first coolant passage 33, which communicates between the intake hole 31 into which the intake pipe 29 of the entrance / exit section 28 described below is mounted and the aforementioned coolant intake hole 25, the second coolant passage 35, which communicates with the outlet hole 32 into which the outlet pipe 30 of the entrance / exit section 28 is mounted and the pipe insertion opening 27, which is the opening end of the communicating pipe 24 and which opens into the aforementioned flange portion 34.

Note that an expansion valve (not shown) is mounted on the aforementioned entrance / exit section 28 and the coolant outlet of the expansion valve is connected to the aforementioned intake pipe 29 and the aforementioned outlet pipe 30 is connected to a passage, for example, in which a thermo-sensing tube is provided.

In the heat exchanger 1 which is structured as described above, the coolant that has reached the first coolant passage 33 from the expansion valve through the intake pipe 29, flows into the tank group 46 of the heat exchanging element group 40 via the coolant intake hole 25, as shown in Figure 3. The coolant which then flows into the tank group 48 on the other side from tank group 46 by going through the U-shaped passages (going and returning) of the heat exchanging element group 40, now flows into the tank group 50 of the heat exchanging element group 42 which communicates with the tank group 48. The coolant then reaches the tank group 52 on the other side from the tank group 50 by way of the U-shaped passages of the heat exchanging element group 42. From the tank group 52, it then passes the tank group 54 of the heat exchanging element group 44, the U-shaped passages (not shown) and the tank group 56. With this, the liquid coolant will have traveled six routes through the heat exchanging elements 2. The heat of the air passing through the fins 3 is absorbed through the fins 3 and the liquid coolant is evaporated into a gaseous coolant.

The coolant which has reached the tank group 56 at the extreme downstream side then travels to the communicating pipe 24 via the tank 36 (communicating passage) formed by the indented portions 19 and 21. It then passes through the communicating pipe 24 and reaches the second coolant passage 35. Then it is sent from the outlet pipe 30 to the next cooling cycle process.

This enables installation of the extension valve at a correct position, since the shapes of the first coolant passage 33 and the second coolant passage 35 can be changed by changing the shape of the intake / outlet passage forming plate 4b and consequently the mounting position of the entrance / exit section 28 can be changed as appropriate.

Note that Figure 6 shows members 24a, 24b, which are formed of a material similar to that of the formed plates, such as clad material and which are formed as two equal portions of the aforementioned communicating pipe 24. By assembling these members 24a, 24b and by brazing them together with the heat exchanger in the furnace, the communicating pipe 24 is formed. Using the same material, thus, will prevent such problems as dimensional irregularities caused by differences in thermal expansion rates among various materials.

Also, the second embodiment, shown in Figure 7, has the communicating pipe 24 divided into the communicating pipe 24' and the communicating pipe 24". This embodiment is provided with the aforementioned heat exchanging elements 2c and the heat exchanging elements 2c' in which the pipe insertion hole is formed at a position that faces opposite the pipe insertion hole 23 of the heat exchanging elements 2c. The aforementioned end plate 4 and the heat exchanging elements 2c' communicate via the communicating pipe 24' and the aforementioned heat exchanging elements 2c' and the heat exchanging elements 2c communicate via the communicating pipe 24". This achieves a reduction in the passage resistance leading to the communicating pipe 24.

The following is an explanation of the laminated heat exchanger 1 in the third embodiment which is shown in Figures 8 - 10. Note that the same key numbers are assigned to components identical to those in the first embodiment and their explanation is omitted.

The heat exchanging element 2d in the third embodiment is formed as shown in Figure 9 by bonding a pair of formed plates 60, 61. With this, the tanks 62, 63 are formed and the opening portions 64, 65 that communicate between both sides of the tanks 62, 63 are formed. Also, in the heat exchanging element 2d, a coolant outlet port 66 is formed, which extends out to the side from the tank 63.

The communicating pipe 67 communicates between the coolant outlet port 66 and the second coolant passage 35 which is formed in the aforementioned end plate 4, and as with the communicating pipe 24 shown in Figure 6, it is structured with members 67a, 67b which are two equal portions. The communicating pipe 67 is also provided with an insertion

hole 68 into which the aforementioned coolant outlet port 66 is fitted. With the communicating pipe 67 structured thus, an advantage is gained that the formed plates 60, 61, which are provided with a coolant outlet as employed in a prior art laminated heat exchanger, can be used. Additionally, similar advantages to those achieved in the aforementioned first embodiment are achieved.

The following is an explanation of the laminated heat exchanger in the fourth embodiment which is shown in Figures 11 - 14.

The heat exchanger 71 in this embodiment is a heat exchanger with, for example, 4 routes and it is assembled by laminating the heat exchanging elements 72 and corrugated fins 73 alternately with the end plates 74, 75 provided at both sides in the direction of the lamination with the whole structure being assembled as a unit in the furnace by brazing.

The heat exchanging element 72 is structured with the heat exchanging element 72a that communicates with the adjacent tanks, the heat exchanging element 72b, which does not communicate with the tank on one side, and the heat exchanging element 72c which is provided with the communicating passage 99.

The heat exchanging element 72a is structured by bonding the formed plates 76, 76 facing each other. The formed plate 76 is provided with two indented portions 77, 78 which are formed by distending the lower portion as shown in Figure 14 and is provided with the elongated raised member 79 which separates the two indented portions 77, 78 and which extends upwards. On the peripheral edge of the elongated raised member 79, a U-shaped groove 80 that communicates between the aforementioned indented portions 77, 78, is formed. Also the opening portions 81, 82 are formed in the aforementioned indented portions 77, 78 respectively.

The heat exchanging element 72b is formed by bonding the aforementioned formed plate 76 and the formed plate 83 facing each other, which are structured identically to each other except that in formed plate 76, only the opening portion on one side, that is, the opening portion 77, is actually open. The whole structure is built thus, so that the tanks on one side communicate with the adjacent tanks, while the tanks on the other side do not communicate with the adjacent tanks.

The heat exchanging element 72c is formed by bonding the aforementioned formed plate 76 and the formed plate 176 facing each other. The formed plate 176 is structured identically to the formed plate 76 except that the opening portion 77 on one side is provided with a pipe insertion hole (201 in Figure 16) into which the communicating passage 99, formed by extending out within the notched portion 89 and one end of the communicating pipe 86 are bonded. With this, the communicating pipe 86 and the tank group 96 communicate via the communicating passage 99.

The aforementioned formed plates 76, 83 are each provided with a notched portion 89, which has a specific length and size, between the two indented portions 77, 78. A plurality of the notched portions 89 are connected continuously to constitute a pipe insertion groove 89' into which a communicating pipe 86 is mounted.

The end plate 74 is structured with the flat plate 74a and the intake / outlet passage forming plate 74b. The flat plate 74a blocks off the formed plate 76 which is positioned at the end, and at the same time, the flat plate 74a is provided with a pipe insertion hole 90 for inserting the aforementioned communicating pipe 86, which opens at a position that corresponds with the aforementioned notched portion 89, and the coolant discharge outlet 91 that opens at a position that faces opposite the aforementioned indented portion 78. In the aforementioned entrance / exit passage forming plate 74b, a first coolant passage 85 that communicates between the aforementioned coolant discharge outlet 91 and the outlet hole 88, into which the outlet pipe 30 of the entrance / exit section 28 is mounted, and the second coolant passage 84 that communicates between the opening end of the aforementioned communicating pipe 86 and the intake hole 87, into which the intake pipe 29 of the aforementioned entrance / exit section 28 is mounted, are formed.

In the heat exchanger 71 structured as described above, the coolant which has flowed in from the expansion valve via the intake pipe 29 to the second coolant passage 84, then travels from the second coolant passage 84 to the communicating pipe 86. This communicating pipe 86 is provided in the pipe insertion groove 89' that is formed by continuously aligning the notched portions 89 that are formed at the center at the lower ends of the aforementioned heat exchanging elements 72 and it extends to the communicating passage 99 which is formed in the heat exchanging elements 72c of the tank group 96 on the upstream side. The coolant that has passed through the aforementioned communicating pipe 86 then flows into the tank group 96 of the heat exchanging element group 92 via the communicating passage 99 which is formed in the heat exchanging elements 72c at the center of the tank group 96. It then passes through the U-shaped passage of the heat exchanging element group 92 and reaches the tank group 98 on the other side.

Since this tank group 98 communicates with the tank group 100 of the heat exchanging element group 94, the coolant then travels to the tank group 100 of the heat exchanging element group 94, and passes through the U-shaped passage of the heat exchanging element group 94 to reach the tank group 102 on the other side. With this, the coolant will have passed through the heat exchanging elements 72 via four

routes, while absorbing the heat of the air passing through the fins 73 which are present among the heat exchanging elements 72, and evaporates from a liquid coolant to a gaseous coolant. This gaseous coolant passes through the first coolant passage 85 that is formed in the end plate 74 to reach the outlet pipe 30 and is finally discharged to the next process.

As has been explained so far, in the heat exchanger in the fourth embodiment also, the mounting position of the expansion valve on the end plate 74 can be freely selected by forming the first coolant passage 85 and the second coolant passage 84 in the end plate 74. Also, as the intake pipe can be left out, the advantage of a reduction in the number of components and, consequently, a saving of space can be achieved. Additionally, since the expansion valve is mounted on the end plate, a reduction in ventilation resistance is achieved.

With the heat exchanger in the fifth embodiment, shown in Figures 15 and 16, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a that communicates with the adjacent tank, the aforementioned heat exchanging element 72b, which does not communicate with the tank on one side, the aforementioned heat exchanging element 72c, which is provided with the communicating passage 199, and the heat exchanging element 72d, which is provided with the communicating passage 200. Note that the explanation of the heat exchanging elements 72a, 72b and 72c is identical to that given earlier and is omitted here.

The heat exchanging element 72d is structured by bonding the formed plate 76 and the formed plate 177 facing each other. The formed plate 177 in turn is provided with a pipe insertion hole 202 which is formed at the identical position to that of the pipe insertion hole 201, which is formed in the aforementioned formed plate 176 and a pipe insertion hole 203, which is formed at a position that faces opposite the pipe insertion hole 202, and it communicates between the pipe insertion hole (first pipe insertion hole) 90, which is formed in the aforementioned end plate 74a, and the pipe insertion hole 202 with the communicating pipe (first communicating pip) 86a, and it also communicates between the pipe insertion hole 203 and the pipe insertion hole 201, which is formed in the heat exchanging element 72c with the second communicating pipe 86b.

With this structure, the heat exchanging elements 72c and 72d are positioned at locations that are not adjacent to each other in the heat exchanging element group 92 and the coolant which has flowed into the communicating pipe 86 (86a, 86b) via the aforementioned second coolant passage 84, then flows into the tank group 96 through two routes, that is, via the first and the second communicating passages 99 and 200. As a result, the passage resistance of the coolant that flows into the heat exchanging element group 92 can be reduced and the temperature distribution of the heat exchanging elements can be made more consistent, thus achieving an improvement in heat exchanging efficiency.

Note that while in the fifth embodiment described above, the communicating pipe that communicates between the first pipe insertion hole 90 and the aforementioned heat exchanging elements 72c, 72d are divided into two portions, 86a and 86b, the first pipe insertion hole 90 and the aforementioned heat exchanging element 72c may communicate via the communicating pipe 86c by passing through the aforementioned heat exchanging element 72d as shown in Figure 17, with the opening portion 86d formed in the area that faces the aforementioned second communicating passage 200 to allow a portion of the coolant to flow through the second communicating passage 200 from this opening portion 86d.

With the heat exchanger in the sixth embodiment, shown in Figures 18 and 19, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a that communicates with the adjacent tanks, the aforementioned heat exchanging element 72b which does not communicate with the tank on one side, and the aforementioned heat exchanging element 72e which is provided with the communicating passage 204. Note that the explanation of the heat exchanging elements 72a, 72b is identical to that given earlier and is omitted here.

The heat exchanging element 72e is formed by bonding the formed plate 178 and the formed plate 179 facing each other. The formed plate 178 is provided with two indented portions 178a and 178b which are formed by distending the lower portion (since they have the same structure as that of the aforementioned indented portion 77, their explanation is omitted) and the indented portion 178a is provided with an opening portion 178c that communicates with the opening portion 81 that is formed in the indented portion 77 of the aforementioned formed plate 76, and the pipe insertion hole 205, which is located at the area 178d (communicating passage forming portion) formed by extending out towards the center.

Also, the formed plate 179 is provided with two indented portions 179a and 179b which are formed by distending the aforementioned lower portion (since they have the same structure as that of the aforementioned indented portion 78, their explanation is omitted) and the indented portion 179a is provided with an opening portion 179c which communicates with the opening portion 82 that is formed in the indented portion 78 of the aforementioned formed plate 76 and the communicating passage forming portion 179d formed by extending out towards the center and which forms the communicating passage 204 by being bonded facing opposite the aforementioned communicating passage forming portion 178d.

In the sixth embodiment, which is structured as described above, since the passage resistance in the communicating passage can be reduced with an increase in the volumetric capacity of the communicating passage, the flow of coolant becomes smoother, resulting in an improvement in the efficiency with which heat exchanging is performed.

With the heat exchanger in the seventh embodiment, shown in Figures 20 and 21, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a that communicates with the adjacent tanks, the aforementioned heat exchanging element 72b which does not communicate with the tank on one side, the aforementioned heat exchanging elements 72f and 72g that constitute the communicating passage 299. Note that the explanation of the heat exchanging elements 72a, 72b is identical to that given earlier and is omitted here.

The heat exchanging element 72f is formed by bonding the formed plate 76 and the formed plate 180 facing each other. The formed plate 180 is provided with two indented portions 180a, 180b (since they are structured identically to the aforementioned indented portion 78 their explanation is omitted) which are formed by distending the lower portion. The indented portion 180a is bonded facing opposite the indented portion 78 of the aforementioned formed plate 76. It is also provided with the pipe insertion hole 206 in the section formed by extending out toward the center. It also has an opening portion 180c in the dorsal area of the indented portion 180a.

The heat exchanging element 72g is formed by bonding the formed plate 76' and the formed plate 181 facing each other. The formed plate 181 is provided with two indented portions 181a, 181b (since they are structured identically to the aforementioned indented portions 77 their explanation is omitted) which are formed by distending the lower portion, and the indented portion 181a is bonded facing opposite the indented portion 77 of the aforementioned formed plate 76' in such a manner that the area that faces the notched portion 89 in the area formed by extending out toward the center is blocked off by the formed plate 76'. Also in the dorsal surface of the indented portion 181a. an opening portion 181c which is bonded with the opening portion 180c formed in the aforementioned formed plate 180 is formed.

By bonding the heat exchanging elements 72f and 72g, which are structured as described above, the communicating passage 299 is formed to achieve similar effects to those achieved by the aforementioned sixth embodiment.

With the heat exchanger in the eighth embodiment, shown in Figures 22 and 23, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a, which communicates with the adjacent tanks, the aforementioned heat exchanging element 72b, which does not communicate with the tank on one side, the aforementioned heat exchanging elements 72h and 72i that constitute the communicating passage 399. Note that the explanation of the heat exchanging elements 72a, 72b is identical to that given earlier and is omitted here.

The heat exchanging element 72h is formed by bonding the aforementioned formed plate 178 and the formed plate 182 facing each other and the heat exchanging element 72i is formed *with the aforementioned* formed plate 181 and the aforementioned formed plate 179, with the formed plate 182 shaped symmetrical to the shape of the aforementioned formed plate 181. Because of this, by bonding the heat exchanging elements 72h and the heat exchanging elements 72i, the volumetric capacity of the communicating passage 399 is increased even more than in the heat exchangers in the sixth and seventh embodiments described above, thus reducing even further the passage resistance in comparison to those embodiments.

The heat exchanger in the ninth embodiment that is shown in Figure 24 is identical to the heat exchanger in the sixth embodiment described earlier except that the position of the heat exchanging element 72e is moved toward the outside by a specific distance from the center of the heat exchanging element group 92. With this, the quantity of coolant that, after flowing out of the communicating pipe and deflecting off the opposing surface, flows toward the inside of the tank group from the communicating passage and the quantity of coolant that flows toward the outside of the tank group can be made uniform. As a result, the temperature distribution of the heat exchanging element group 92 is more uniform, as shown by N in Figure 25 compared with the temperature distribution shown by M in the same figure, achieving an improvement in efficiency with which the heat exchanger performs heat exchanging.

The embodiment shown in Figure 26 shows the bonding state of the communicating pipe, and to quote the heat exchanger of the fourth embodiment, shown in Figures 18 and 19 as an explanatory example, Figure 26a shows the bonding state between one end of the aforementioned communicating pipe 86 and the first pipe insertion hole 90. Figure 26(b) shows the bonding state between the other end of the aforementioned communicating pipe 86 and the second pipe insertion hole 205. In this example, a flange for insertion 90a is formed around the aforementioned first pipe insertion hole 90, and by brazing the internal circumferential surface of the flange for insertion 90a to the external circumference at one end of the aforementioned communicating pipe 86, they are bonded.

Figure 26(b) shows the state in which the other end of the communicating pipe 86 is bonded to the heat exchanging element 72d. In this figure, a small diameter portion 86f, which is formed at the end of the

routes, while absorbing the heat of the air passing through the fins 73 which are present among the heat exchanging elements 72, and evaporates from a liquid coolant to a gaseous coolant. This gaseous coolant passes through the first coolant passage 85 that is formed in the end plate 74 to reach the outlet pipe 30 and is finally discharged to the next process.

As has been explained so far, in the heat exchanger in the fourth embodiment also, the mounting position of the expansion valve on the end plate 74 can be freely selected by forming the first coolant passage 85 and the second coolant passage 84 in the end plate 74. Also, as the intake pipe can be left out, the advantage of a reduction in the number of components and, consequently, a saving of space can be achieved. Additionally, since the expansion valve is mounted on the end plate, a reduction in ventilation resistance is achieved.

With the heat exchanger in the fifth embodiment, shown in Figures 15 and 16, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a that communicates with the adjacent tank, the aforementioned heat exchanging element 72b, which does not communicate with the tank on one side, the aforementioned heat exchanging element 72c, which is provided with the communicating passage 199, and the heat exchanging element 72d, which is provided with the communicating passage 200. Note that the explanation of the heat exchanging elements 72a, 72b and 72c is identical to that given earlier and is omitted here.

The heat exchanging element 72d is structured by bonding the formed plate 76 and the formed plate 177 facing each other. The formed plate 177 in turn is provided with a pipe insertion hole 202 which is formed at the identical position to that of the pipe insertion hole 201, which is formed in the aforementioned formed plate 176 and a pipe insertion hole 203, which is formed at a position that faces opposite the pipe insertion hole 202, and it communicates between the pipe insertion hole (first pipe insertion hole) 90, which is formed in the aforementioned end plate 74a, and the pipe insertion hole 202 with the communicating pipe (first communicating pip) 86a, and it also communicates between the pipe insertion hole 203 and the pipe insertion hole 201, which is formed in the heat exchanging element 72c with the second communicating pipe 86b.

With this structure, the heat exchanging elements 72c and 72d are positioned at locations that are not adjacent to each other in the heat exchanging element group 92 and the coolant which has flowed into the communicating pipe 86 (86a, 86b) via the aforementioned second coolant passage 84, then flows into the tank group 96 through two routes, that is, via the first and the second communicating passages 99 and 200. As a result, the passage resistance of the coolant that flows into the heat exchanging element group 92 can be reduced and the temperature distribution of the heat exchanging elements can be made more consistent, thus achieving an improvement in heat exchanging efficiency.

Note that while in the fifth embodiment described above, the communicating pipe that communicates between the first pipe insertion hole 90 and the aforementioned heat exchanging elements 72c, 72d are divided into two portions, 86a and 86b, the first pipe insertion hole 90 and the aforementioned heat exchanging element 72c may communicate via the communicating pipe 86c by passing through the aforementioned heat exchanging element 72d as shown in Figure 17, with the opening portion 86d formed in the area that faces the aforementioned second communicating passage 200 to allow a portion of the coolant to flow through the second communicating passage 200 from this opening portion 86d.

With the heat exchanger in the sixth embodiment, shown in Figures 18 and 19, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a that communicates with the adjacent tanks, the aforementioned heat exchanging element 72b which does not communicate with the tank on one side, and the aforementioned heat exchanging element 72e which is provided with the communicating passage 204. Note that the explanation of the heat exchanging elements 72a, 72b is identical to that given earlier and is omitted here.

The heat exchanging element 72e is formed by bonding the formed plate 178 and the formed plate 179 facing each other. The formed plate 178 is provided with two indented portions 178a and 178b which are formed by distending the lower portion (since they have the same structure as that of the aforementioned indented portion 77, their explanation is omitted) and the indented portion 178a is provided with an opening portion 178c that communicates with the opening portion 81 that is formed in the indented portion 77 of the aforementioned formed plate 76, and the pipe insertion hole 205, which is located at the area 178d (communicating passage forming portion) formed by extending out towards the center.

Also, the formed plate 179 is provided with two indented portions 179a and 179b which are formed by distending the aforementioned lower portion (since they have the same structure as that of the aforementioned indented portion 78, their explanation is omitted) and the indented portion 179a is provided with an opening portion 179c which communicates with the opening portion 82 that is formed in the indented portion 78 of the aforementioned formed plate 76 and the communicating passage forming portion 179d formed by extending out towards the center and which forms the communicating passage 204 by being bonded facing opposite the aforementioned communicating passage forming portion 178d.

In the sixth embodiment, which is structured as described above, since the passage resistance in the communicating passage can be reduced with an increase in the volumetric capacity of the communicating passage, the flow of coolant becomes smoother, resulting in an improvement in the efficiency with which heat exchanging is performed.

With the heat exchanger in the seventh embodiment, shown in Figures 20 and 21, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a that communicates with the adjacent tanks, the aforementioned heat exchanging element 72b which does not communicate with the tank on one side, the aforementioned heat exchanging elements 72f and 72g that constitute the communicating passage 299. Note that the explanation of the heat exchanging elements 72a, 72b is identical to that given earlier and is omitted here.

The heat exchanging element 72f is formed by bonding the formed plate 76 and the formed plate 180 facing each other. The formed plate 180 is provided with two indented portions 180a, 180b (since they are structured identically to the aforementioned indented portion 78 their explanation is omitted) which are formed by distending the lower portion. The indented portion 180a is bonded facing opposite the indented portion 78 of the aforementioned formed plate 76. It is also provided with the pipe insertion hole 206 in the section formed by extending out toward the center. It also has an opening portion 180c in the dorsal area of the indented portion 180a.

The heat exchanging element 72g is formed by bonding the formed plate 76' and the formed plate 181 facing each other. The formed plate 181 is provided with two indented portions 181a, 181b (since they are structured identically to the aforementioned indented portions 77 their explanation is omitted) which are formed by distending the lower portion, and the indented portion 181a is bonded facing opposite the indented portion 77 of the aforementioned formed plate 76' in such a manner that the area that faces the notched portion 89 in the area formed by extending out toward the center is blocked off by the formed plate 76'. Also in the dorsal surface of the indented portion 181a, an opening portion 181c which is bonded with the opening portion 180c formed in the aforementioned formed plate 180 is formed.

By bonding the heat exchanging elements 72f and 72g, which are structured as described above, the communicating passage 299 is formed to achieve similar effects to those achieved by the aforementioned sixth embodiment.

With the heat exchanger in the eighth embodiment, shown in Figures 22 and 23, the heat exchanging element 72 consists of the aforementioned heat exchanging element 72a, which communicates with the adjacent tanks, the aforementioned heat exchanging element 72b, which does not communicate with the tank on one side, the aforementioned heat exchanging elements 72h and 72i that constitute the communicating passage 399. Note that the explanation of the heat exchanging elements 72a, 72b is identical to that given earlier and is omitted here.

The heat exchanging element 72h is formed by bonding the aforementioned formed plate 178 and the formed plate 182 facing each other and the heat exchanging element 72i is formed with the *aforementioned* formed plate 181 and the aforementioned formed plate 179, with the formed plate 182 shaped symmetrical to the shape of the aforementioned formed plate 181. Because of this, by bonding the heat exchanging elements 72h and the heat exchanging elements 72i, the volumetric capacity of the communicating passage 399 is increased even more than in the heat exchangers in the sixth and seventh embodiments described above, thus reducing even further the passage resistance in comparison to those embodiments.

The heat exchanger in the ninth embodiment that is shown in Figure 24 is identical to the heat exchanger in the sixth embodiment described earlier except that the position of the heat exchanging element 72e is moved toward the outside by a specific distance from the center of the heat exchanging element group 92. With this, the quantity of coolant that, after flowing out of the communicating pipe and deflecting off the opposing surface, flows toward the inside of the tank group from the communicating passage and the quantity of coolant that flows toward the outside of the tank group can be made uniform. As a result, the temperature distribution of the heat exchanging element group 92 is more uniform, as shown by N in Figure 25 compared with the temperature distribution shown by M in the same figure, achieving an improvement in efficiency with which the heat exchanger performs heat exchanging.

The embodiment shown in Figure 26 shows the bonding state of the communicating pipe, and to quote the heat exchanger of the fourth embodiment, shown in Figures 18 and 19 as an explanatory example, Figure 26a shows the bonding state between one end of the aforementioned communicating pipe 86 and the first pipe insertion hole 90. Figure 26(b) shows the bonding state between the other end of the aforementioned communicating pipe 86 and the second pipe insertion hole 205. In this example, a flange for insertion 90a is formed around the aforementioned first pipe insertion hole 90, and by brazing the internal circumferential surface of the flange for insertion 90a to the external circumference at one end of the aforementioned communicating pipe 86, they are bonded.

Figure 26(b) shows the state in which the other end of the communicating pipe 86 is bonded to the heat exchanging element 72d. In this figure, a small diameter portion 86f, which is formed at the end of the

communicating pipe 86, is inserted into the second pipe insertion hole 205, which is formed in the formed plate 178. The aforementioned other end of the communicating pipe 86 is bonded by brazing the external circumference of the small diameter portion 86f together with the internal circumference of the aforementioned second pipe insertion hole 205.

The embodiment shown in Figures 27(a) and (b), is provided with the guides 86g, 86h at the ends of the aforementioned communicating pipe 86 in order to reduce the passage resistance of the coolant. This enables the coolant to flow smoothly from the second communicating passage 84 into the communicating pipe 86 and from the communicating pipe 86 into the communicating passage 204, resulting in a reduction in passage resistance.

In the heat exchangers presented in the nine embodiments described above, the explanation is based on a fixed flow of the coolant in a specific direction. However, in heat exchangers in which the coolant flows in the opposite direction, similar advantages are achieved and therefore the invention does not restrict the flow direction of the coolant.

As has been explained so far, with the present invention, by forming a first coolant passage that communicates with one end of the coolant path and a second coolant passage that communicates with the other end of the coolant path in one of the end plates and by changing the form of these paths, the width and position of the entrance / exit section that connects with the expansion valve can be freely changed, enabling the mounting of the expansion valve at an optimal position.

Also, by having the second coolant passage communicate with the tank group that constitutes the end of the coolant path via the communicating pipe, even in heat exchangers with varying number of routes and different directions of passage, it is possible to locate the entrance / exit section on one of the end plates, making it possible to mount the expansion valve at a specific position.

Furthermore, by structuring the communicating passage that communicates between the communicating pipe and the tank group that constitutes the end of the coolant path with a plurality of formed plates, the passage resistance can be reduced when the coolant flows in and out between the communicating pipe and the heat exchanging elements, achieving an improvement in the efficiency with which heat exchanging is performed.

Claims

1. A laminated heat exchanger which is provided with heat exchanging elements, each of which is formed by bonding formed plates facing each other to create a pair of tanks and a U-shaped passage that communicates between said pair of tanks,

    said heat exchanging elements are alternately laminated with corrugated fins, and end plates are provided at both ends in the direction of lamination,

    a coolant path wherein the tanks that are adjacent with each other in said direction of lamination on one side communicate with each other, and are, at the same time, partitioned at specific positions to form a plurality of tank groups on one side,

    the tanks on the other side communicate with each other and are, at the same time, partitioned at a specific position to form a plurality of tank groups on the other side, and

    a plurality of layers of routes, each of which is formed with one of the tank groups on one side, the U-shaped passage that communicates with that particular tank group and the tank group on the other side that communicates with said U-shaped passage,

    specific tank groups that are adjacent to each other in the direction of lamination are in communication with each other in such a manner that said routes are connected in series, comprising:

    an intake / outlet passage forming plate, which is bonded onto one of said end plates and which is provided with an entrance / exit section onto which an expansion valve unit is mounted,

    a first coolant passage that communicates between one end of said first coolant passage and one side of said entrance / exit section,

    a second coolant passage that communicates between the other side of said entrance / exit section and a pipe insertion hole that is formed in said one of said end plates, and

    a communicating pipe, one end of which is bonded to said pipe insertion hole that communicates with said second coolant passage and the other end of which communicates with the other end of said coolant path.

2. A laminated heat exchanger according to claim 1 wherein:

    one end of said communicating pipe communicates with a pipe insertion hole that is formed in an extended portion that extends out to the side from the lower portion of said end plate and said intake / outlet passage forming plate, and the other end is inserted into a second pipe insertion hole in a communicating passage formed by extending toward the outside from a specific tank in the tank group at the other end of said coolant path to communicate with said other end of said coolant path.

3. A laminated heat exchanger according to claim 2 wherein:

in said coolant path, the tank group that communicates with said first coolant passage is upstream and the tank group that communicates with said communicating pipe is downstream.

4. A laminated heat exchanger according to claim 2 wherein:

said communicating pipe is formed by bonding semi-cylindrical plates facing each other.

5. A laminated heat exchanger according to claim 2 wherein: said communicating pipe is formed by bonding a semi-cylindrical plate facing a plate in which an insertion hole for inserting an extended pipe formed by extending from said tank at said specific position.

6. A laminated heat exchanger according to claim 1 wherein:

one end of said communicating pipe communicates with a pipe insertion hole that is formed in said extended portion that extends out to the side from the lower portion of said end plate and said intake / outlet passage forming plate, and the other end communicates with a pipe insertion hole which is formed in an extended portion that extends toward the side from a plurality of tanks which do not lie adjacent to one another in the tank group at the other end of said coolant path.

7. A laminated heat exchanger according to claim 6 wherein:

said communicating pipe comprises:

a first communicating pipe that communicates between a pipe insertion hole that is formed in said one of said end plates and a pipe insertion hole formed in said extended portion that is at the closest to said pipe insertion hole, and

a second communicating pipe that communicates between said extended portion and the next extended portion.

8. A laminated heat exchanger according to claim 6 wherein:

said communicating pipe communicates between said pipe insertion hole formed in said one of said end plates and a pipe insertion hole which passes through the extended portion positioned between said pipe insertion hole and the extended portion the farthest from said pipe insertion hole and which is formed in said farthest extended portion, and

said communicating pipe is provided with an opening portion that opens into the extended portion where the hole passes through.

9. A laminated heat exchanger according to claim 1 wherein:

said communicating pipe is provided in a pipe insertion groove which is formed between said tank groups on one side and said tank groups on the other side,

one end of said communicating pipe communicates with a pipe *insertion hole that is* formed at the bottom center of said end plate and said intake / outlet passage forming plate that is bonded onto said end plate and which communicates with said second coolant passage, and

the other end of said communicating pipe communicates with a second pipe insertion hole that is formed at the bottom center of the other one of said end plates with a bypass provided that communicates between said second pipe insertion hole and the end of the tank group constituting the other end of said coolant path provided in said other end plate.

10. A laminated heat exchanger according to claim 1 wherein:

said communicating pipe is provided in a pipe insertion groove which is formed between said tank groups on one side and said tank groups on the other side,

one end of said communicating pipe communicates with a pipe insertion hole that is formed at the bottom center of said end plate and said intake / outlet passage forming plate that is bonded onto said end plate and which communicates with said second coolant passage, and

the other end of said communicating pipe communicates with a second pipe insertion hole that is formed in an extended portion that extends out toward said pipe insertion groove from a tank in the tank group constituting the other end of said coolant path.

11. A laminated heat exchanger according to claim 1 wherein:

said communicating pipe is provided in a pipe insertion groove which is formed between said tank groups on one side and said tank groups on the other side,

one end of said communicating pipe communicates with a pipe insertion hole that is formed at the bottom center of said end plate and said intake / outlet passage forming plate that is bonded onto said end plate and which communicates with said second coolant passage, and

the other end of said communicating pipe communicates astride with the communicating passages formed by extending out toward said pipe insertion groove from at least two tanks which are not adjacent to each other in the tank group constituting the other end of said coolant

path.

12. A laminated heat exchanger according to claim 1 wherein:
said communicating pipe is provided in a pipe insertion groove which is formed between said tank groups on one side and said tank groups on the other side,
one end of said communicating pipe communicates with a pipe insertion hole that is formed at the bottom center of said end plate and said intake / outlet passage forming plate that is bonded onto said end plate and which communicates with said second coolant passage, and
the other end of said communicating pipe communicates with a communicating passage formed by extending out toward said pipe insertion groove from a tank constituted with two continuous formed plates that belong to the tank group constituting the other side of said coolant path.

13. A laminated heat exchanger according to claim 12 wherein:
said communicating passage is formed by extending the tank forming area of a pair of formed plates that are bonded facing each other, out toward said pipe insertion groove.

14. A laminated heat exchanger according to claim 12 wherein:
said communicating passage is formed by extending the tank forming area of a pair of formed plates that are bonded back-to-back, out toward said pipe insertion groove.

15. A laminated heat exchanger according to claim 1 wherein:
said communicating pipe is provided in a pipe insertion groove which is formed between said tank groups on one side and said tank groups on the other side,
one end of said communicating pipe communicates with a pipe insertion hole that is formed at the bottom center of said end plate and said intake / outlet passage forming plate that is bonded onto said end plate and which communicates with said second coolant passage, and
the other end of said communicating pipe communicates with a communicating passage formed in the extended portion that extends out toward said pipe insertion groove from the tank which is located at a specific position toward the outside from the center of the tank group that constitutes the other end of said coolant path.

16. A laminated heat exchanger according to claim 1 wherein:
said communicating pipe is provided with guides formed by notching, in the direction of the flow of the coolant, both ends of the pipe which are inserted into said pipe insertion hole and a second pipe insertion hole notching.

FIG. 1

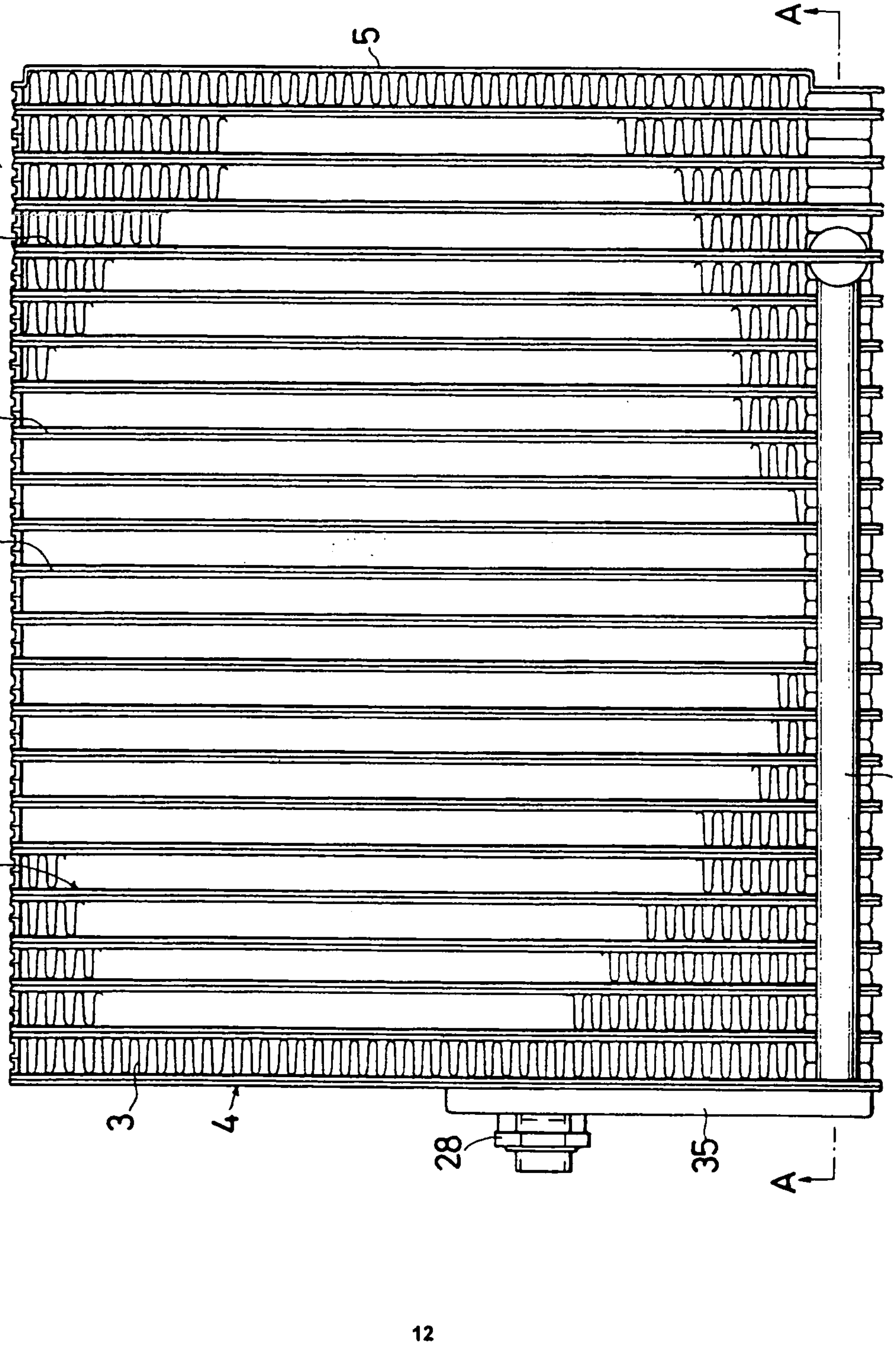

FIG. 2

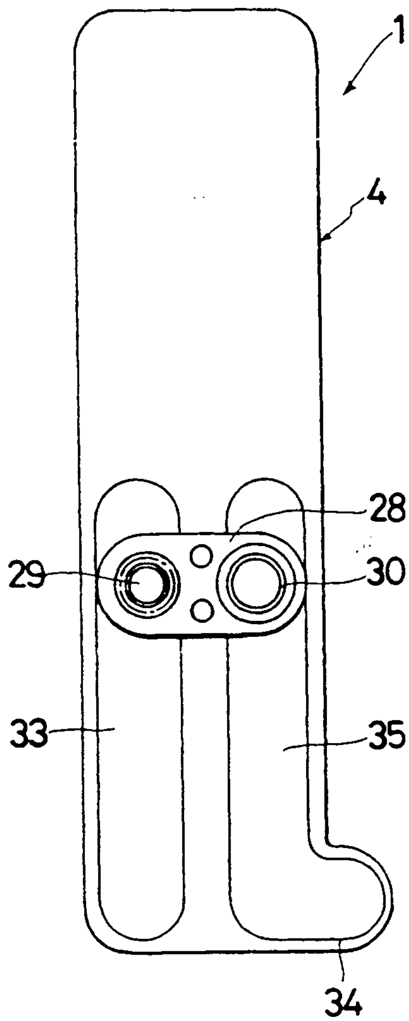
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FIG. 3

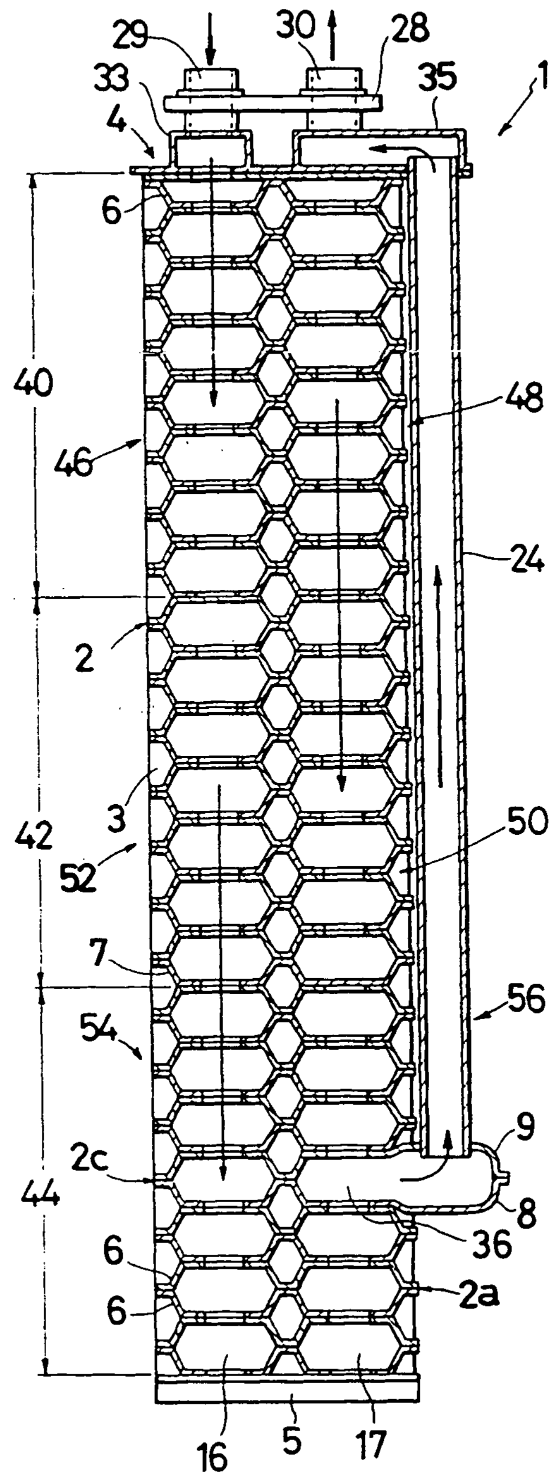
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FIG. 4

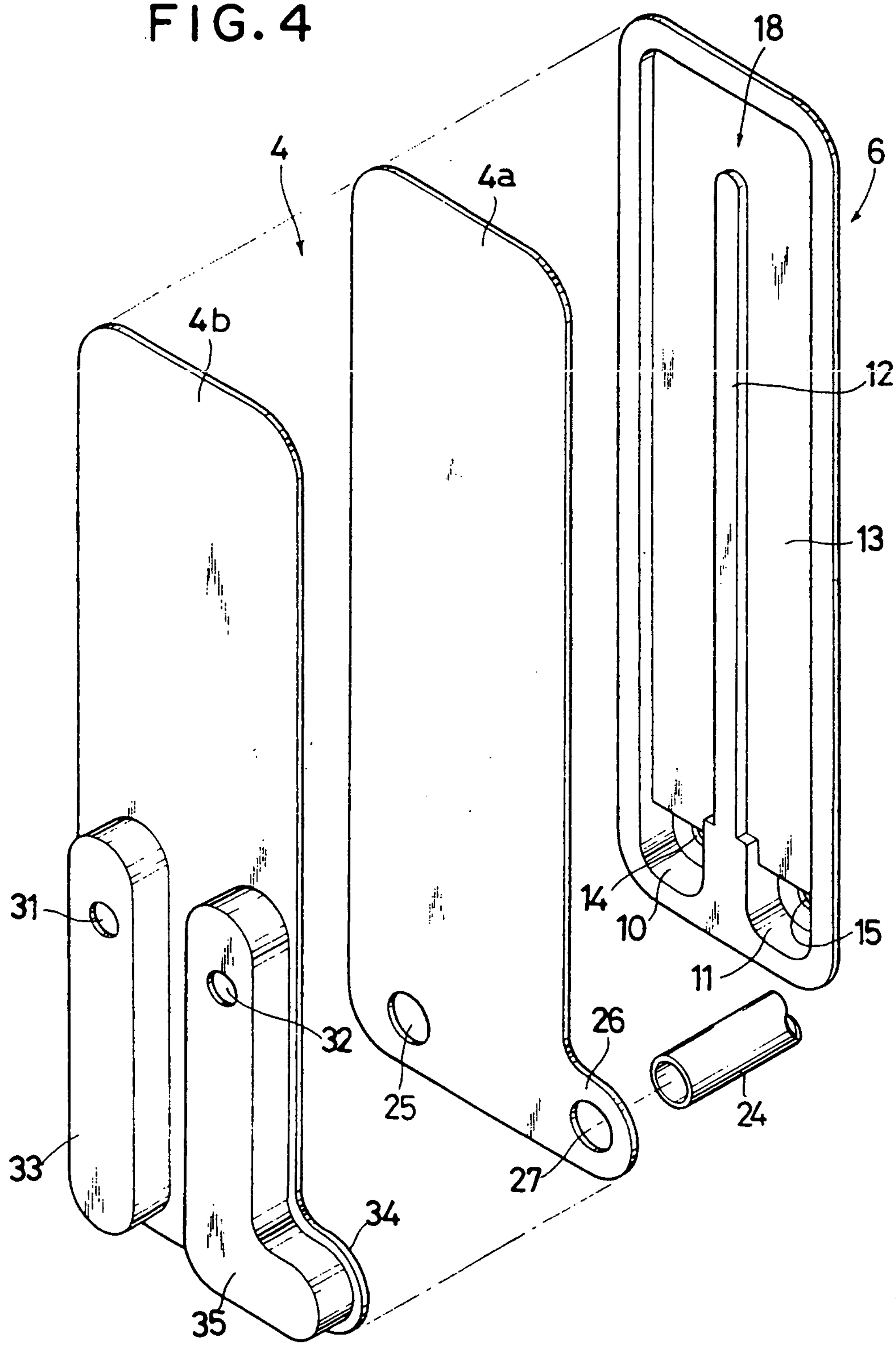

FIG. 5

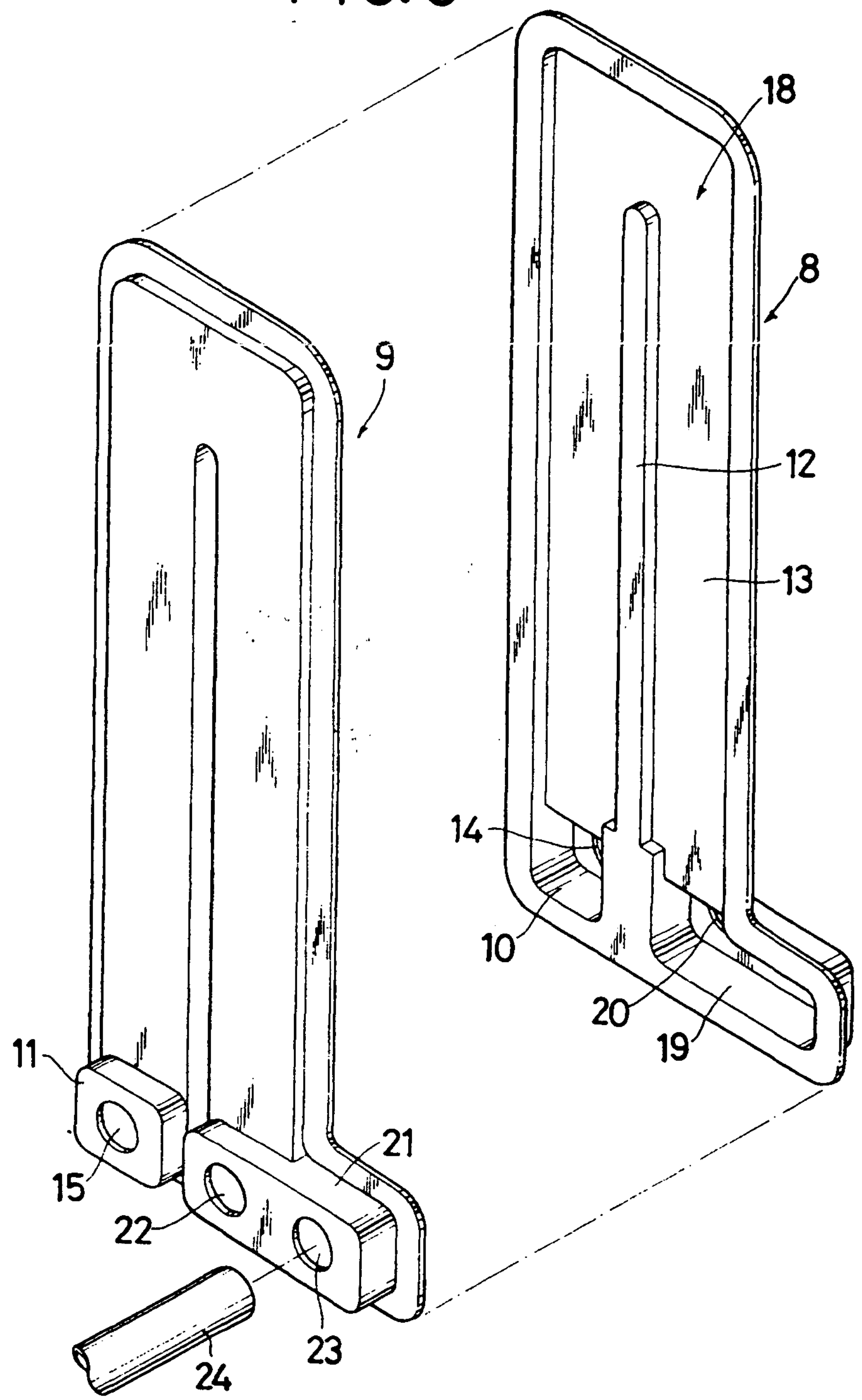

FIG. 6

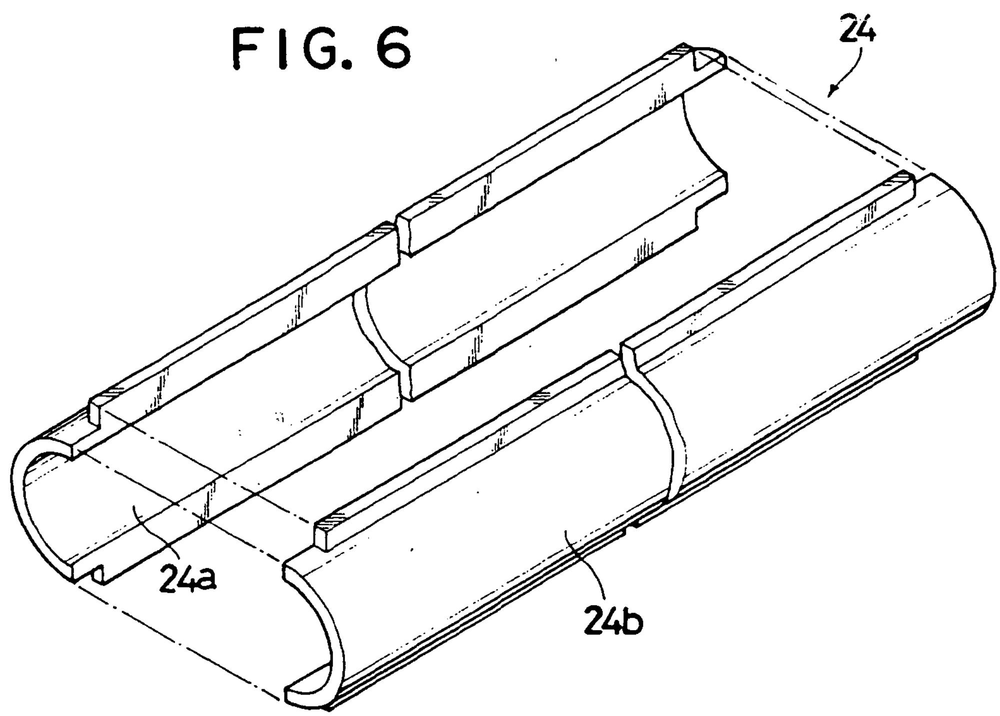

FIG. 7

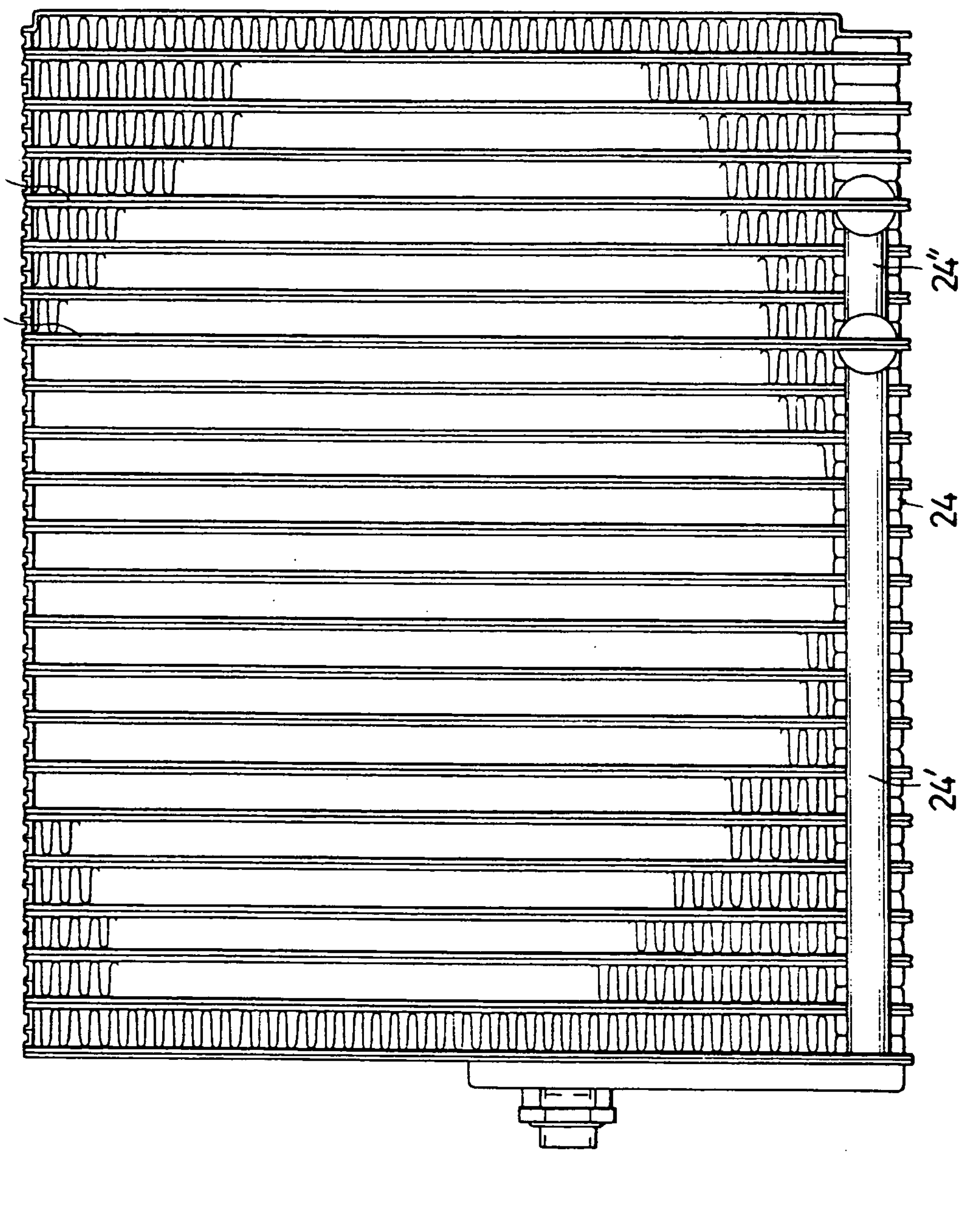

FIG. 8

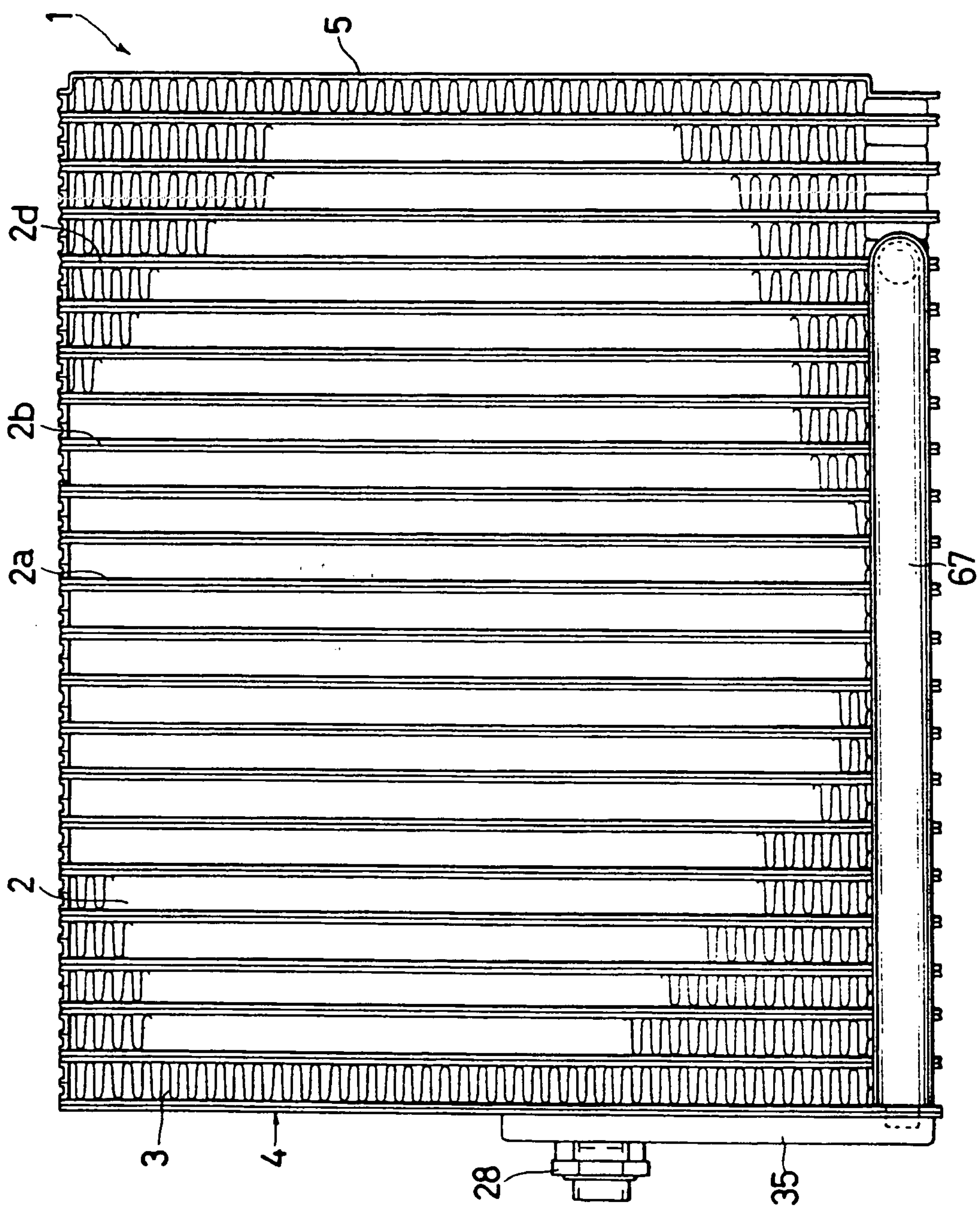

FIG. 9

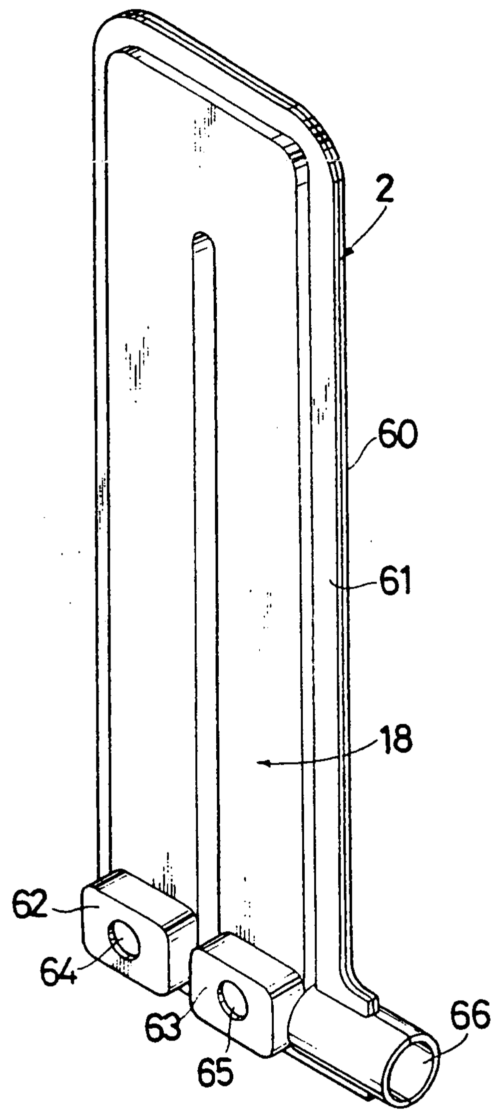

FIG. 10

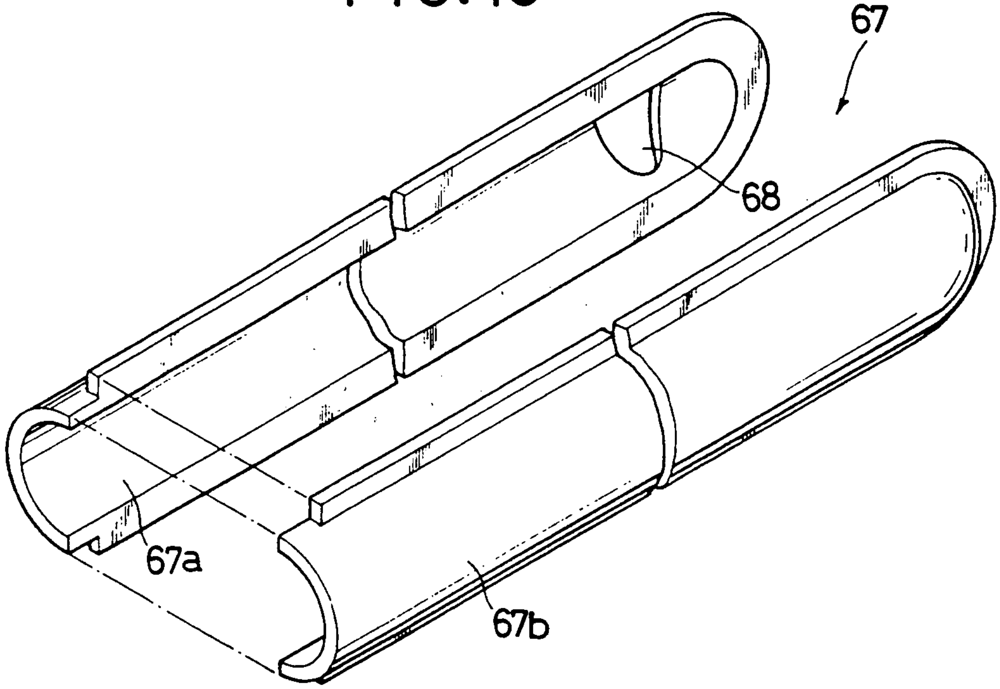

FIG. 11

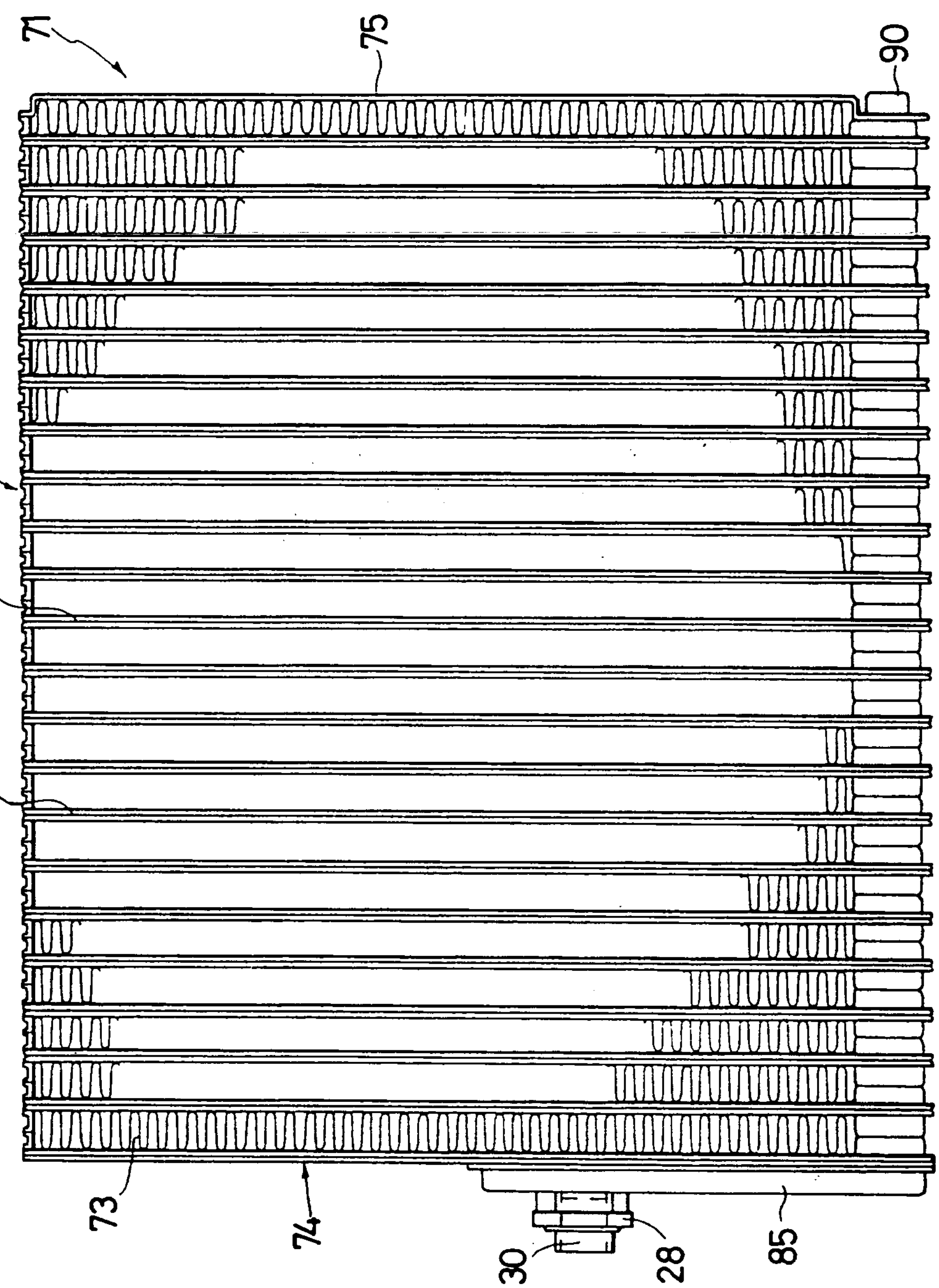

FIG. 12

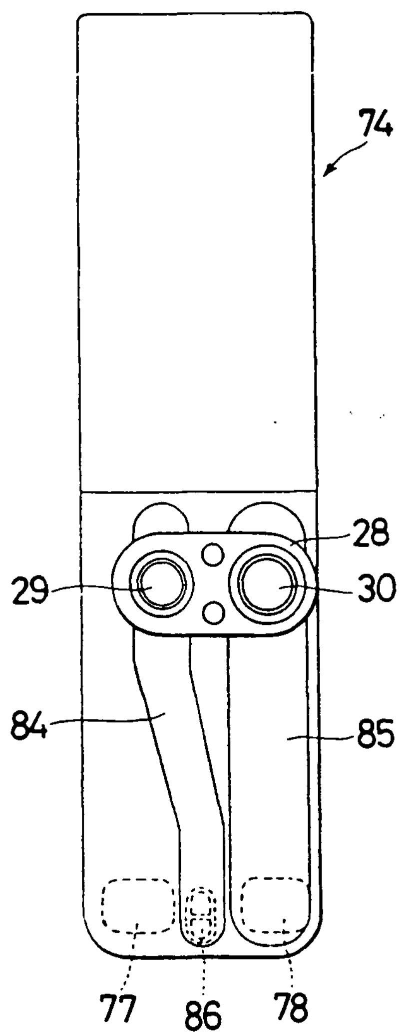
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FIG. 13

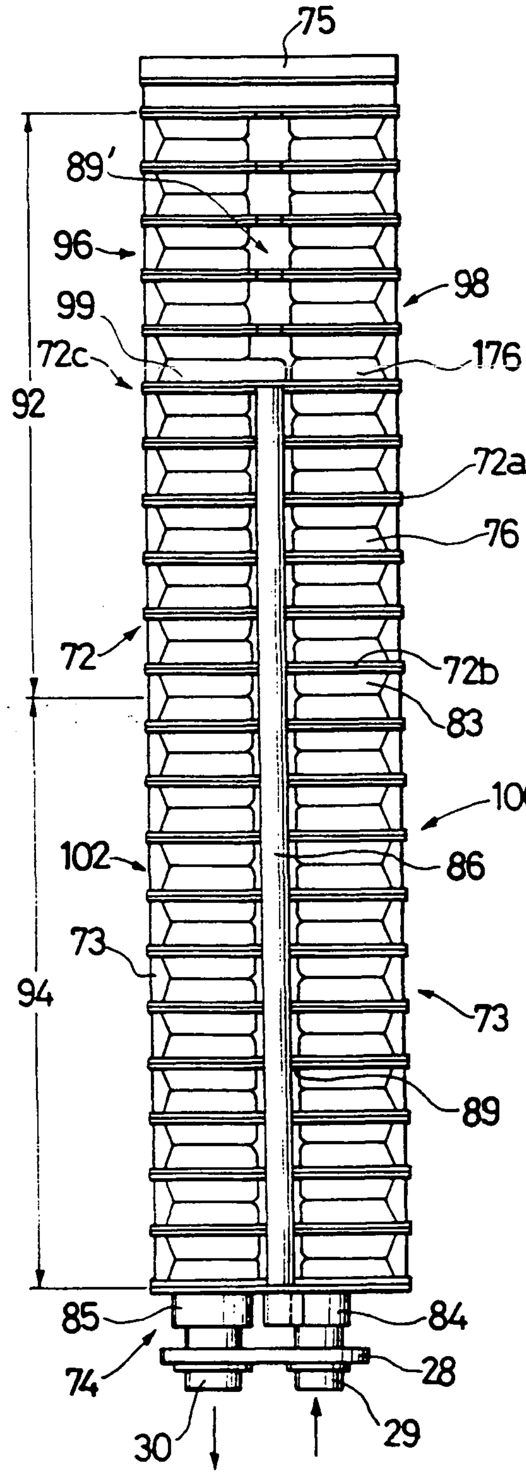
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FIG. 14

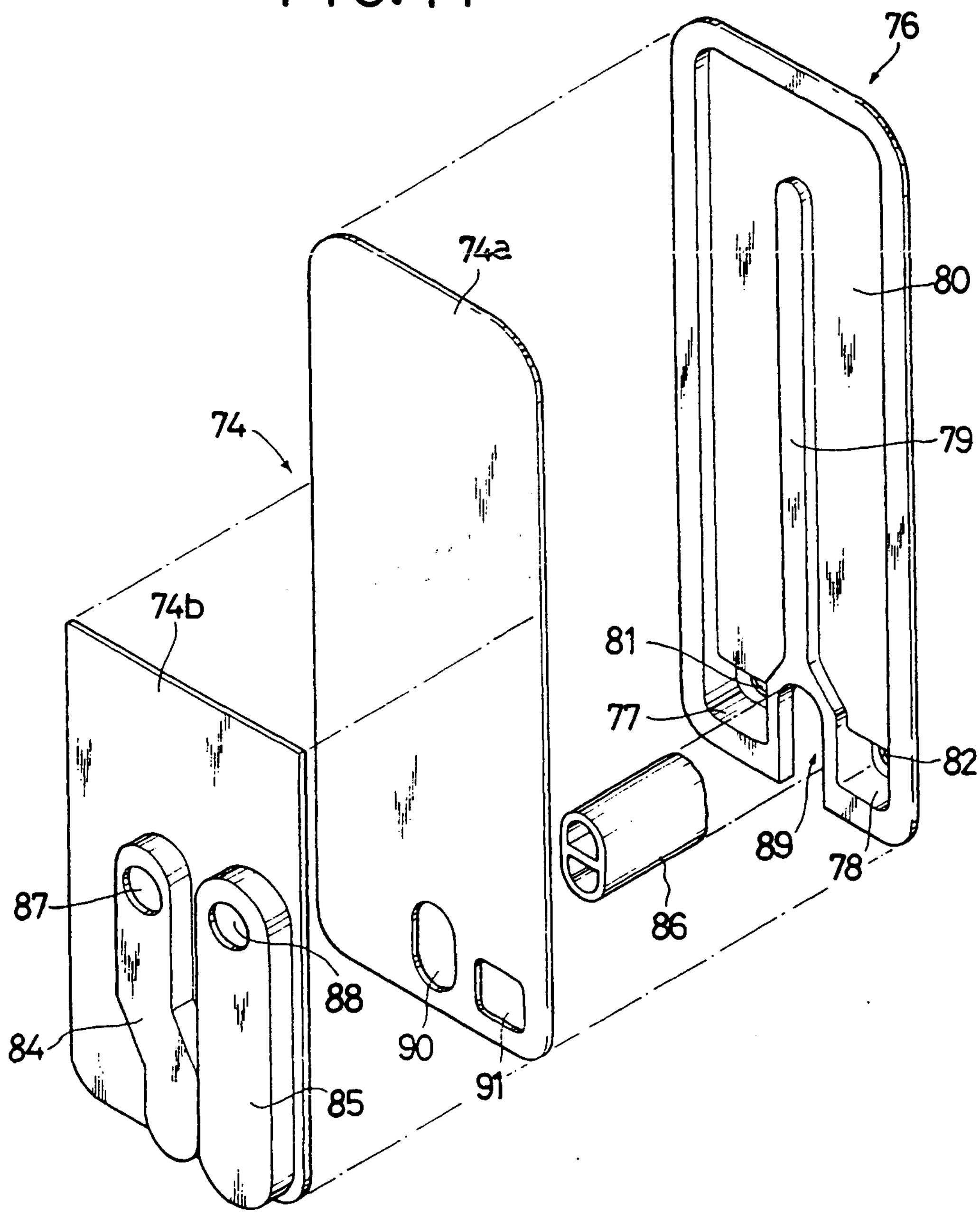

FIG. 15

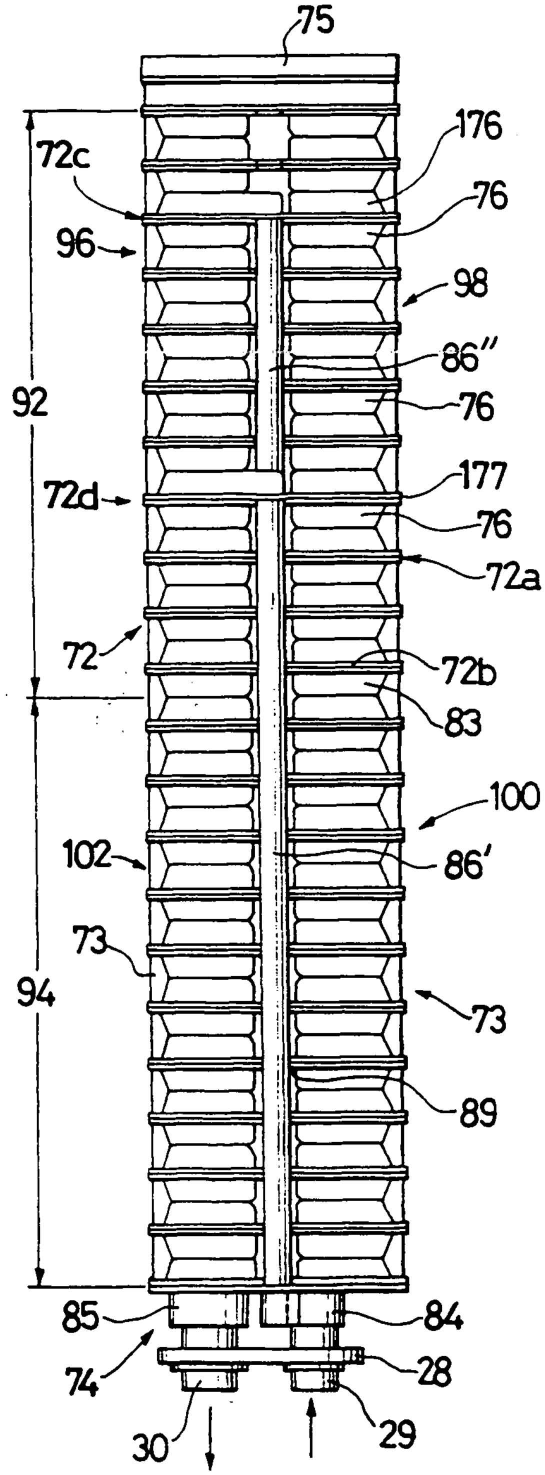
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FIG. 16

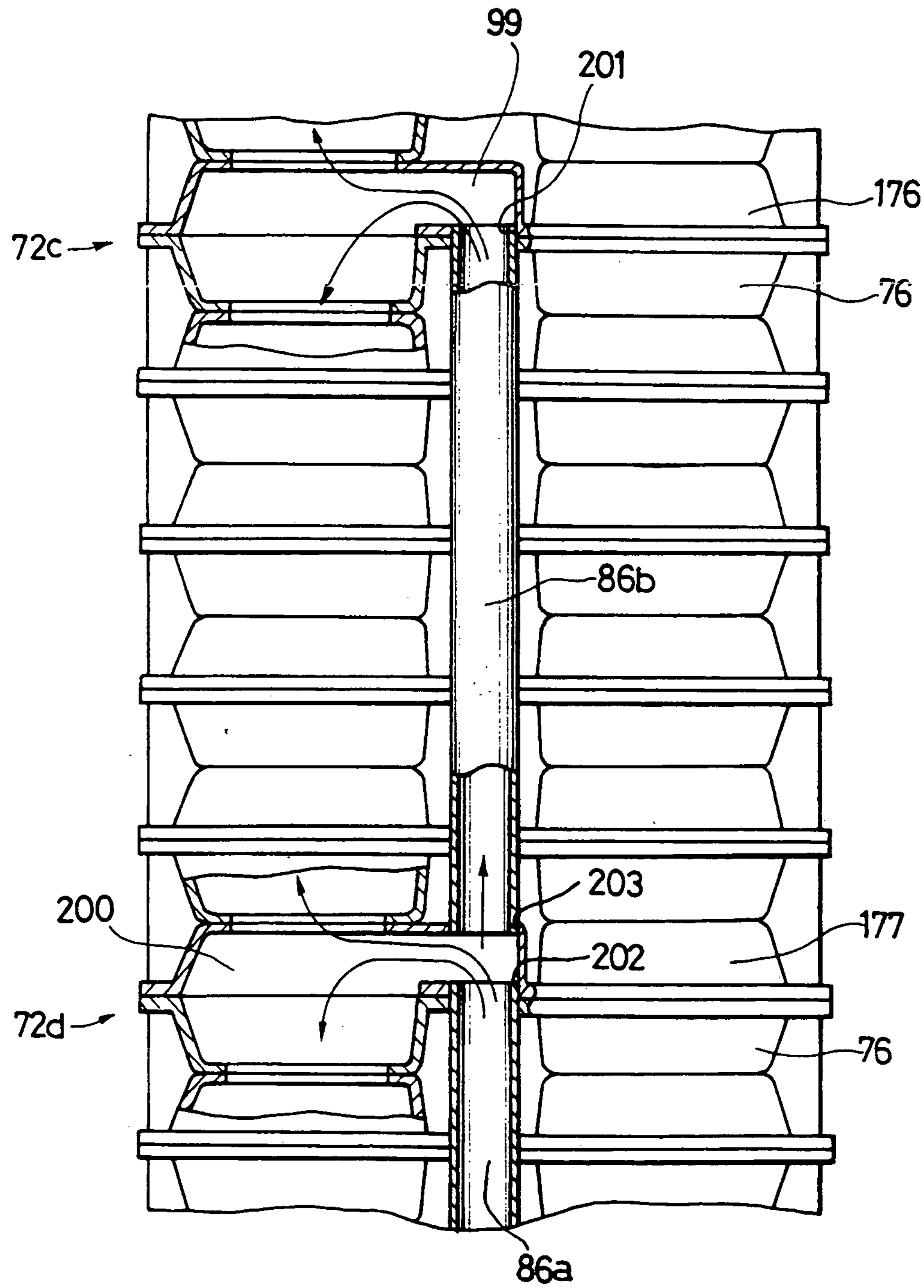

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FIG. 17

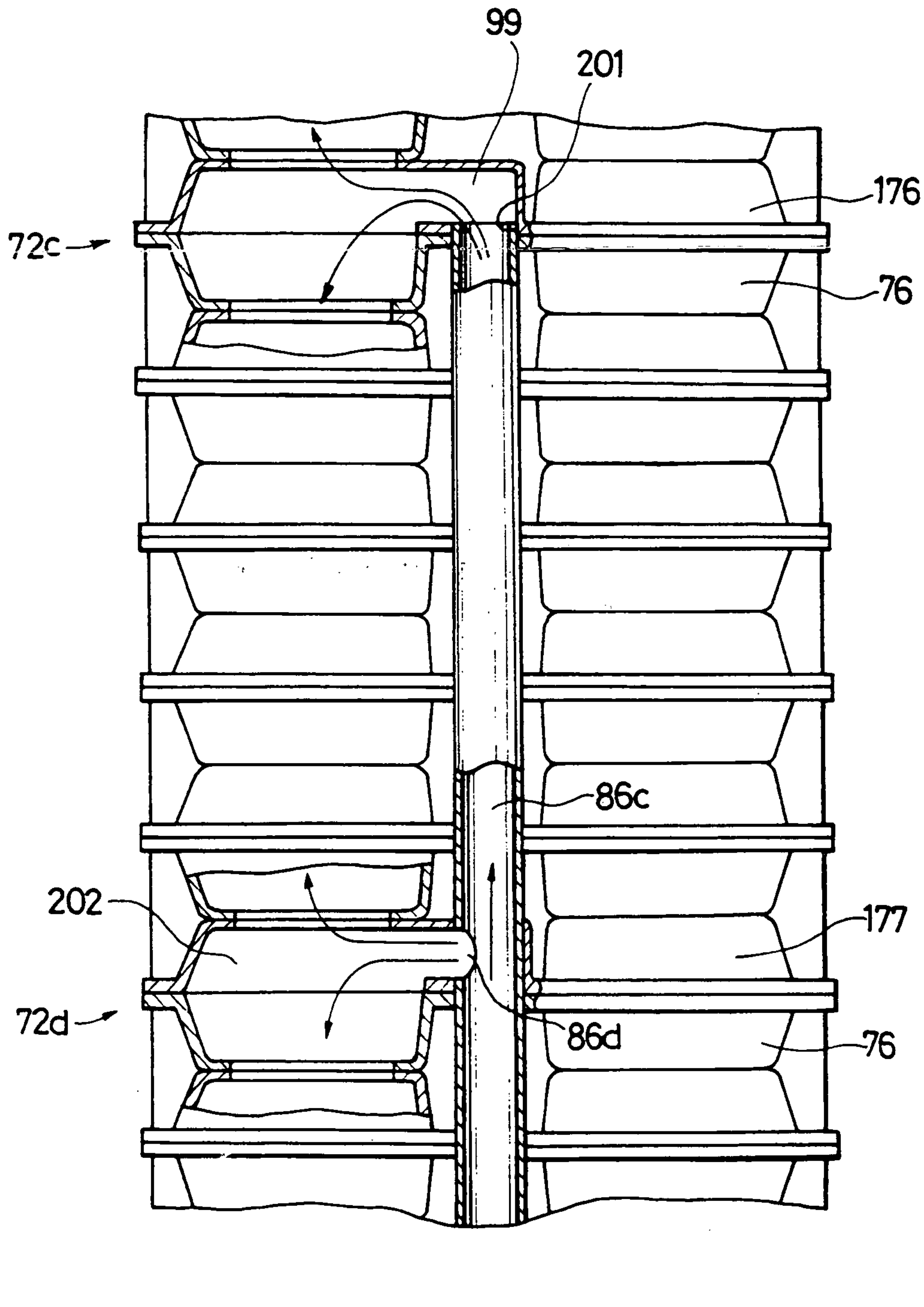

FIG. 18

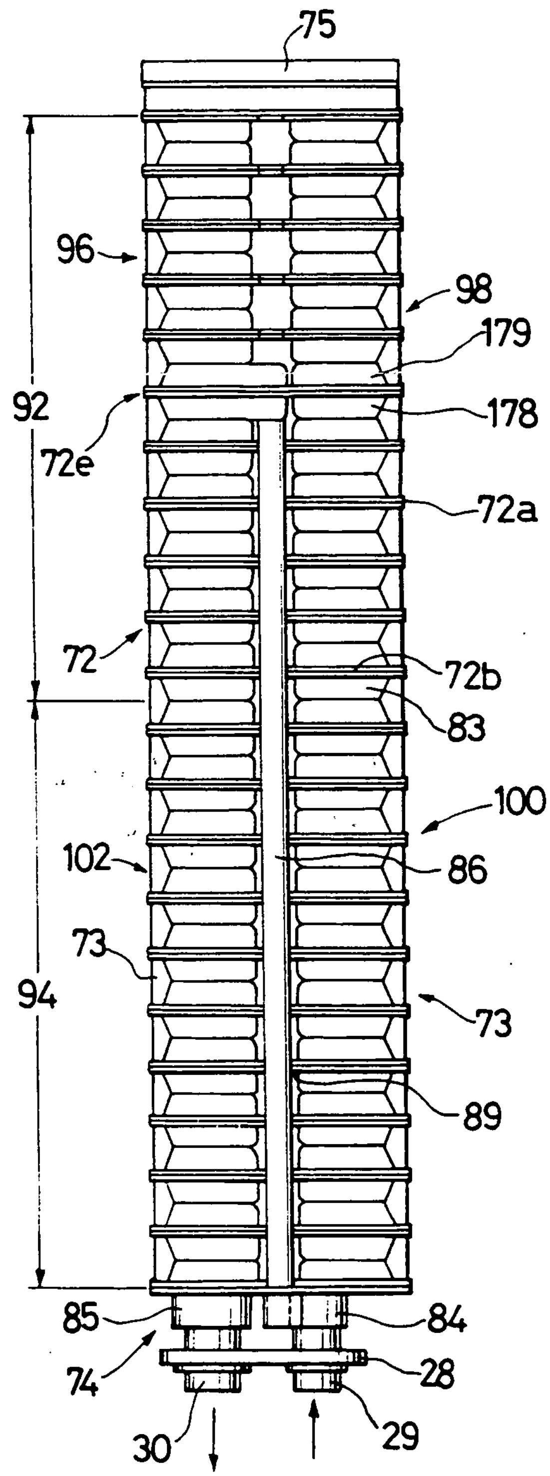
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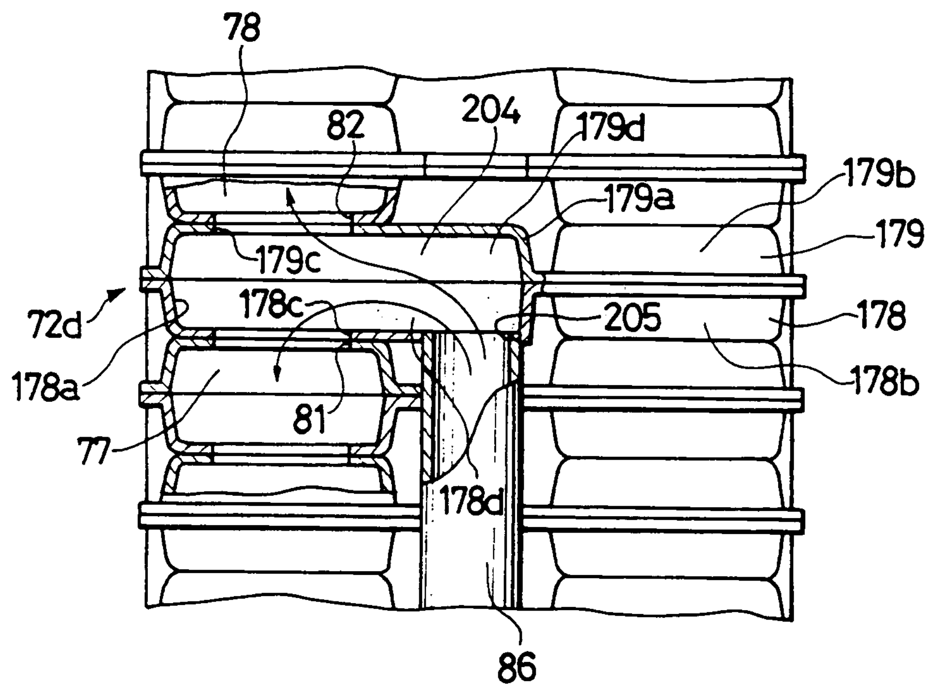
FIG. 19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179c
72d
178c
205
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178a
178b
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178d
86

FIG. 20

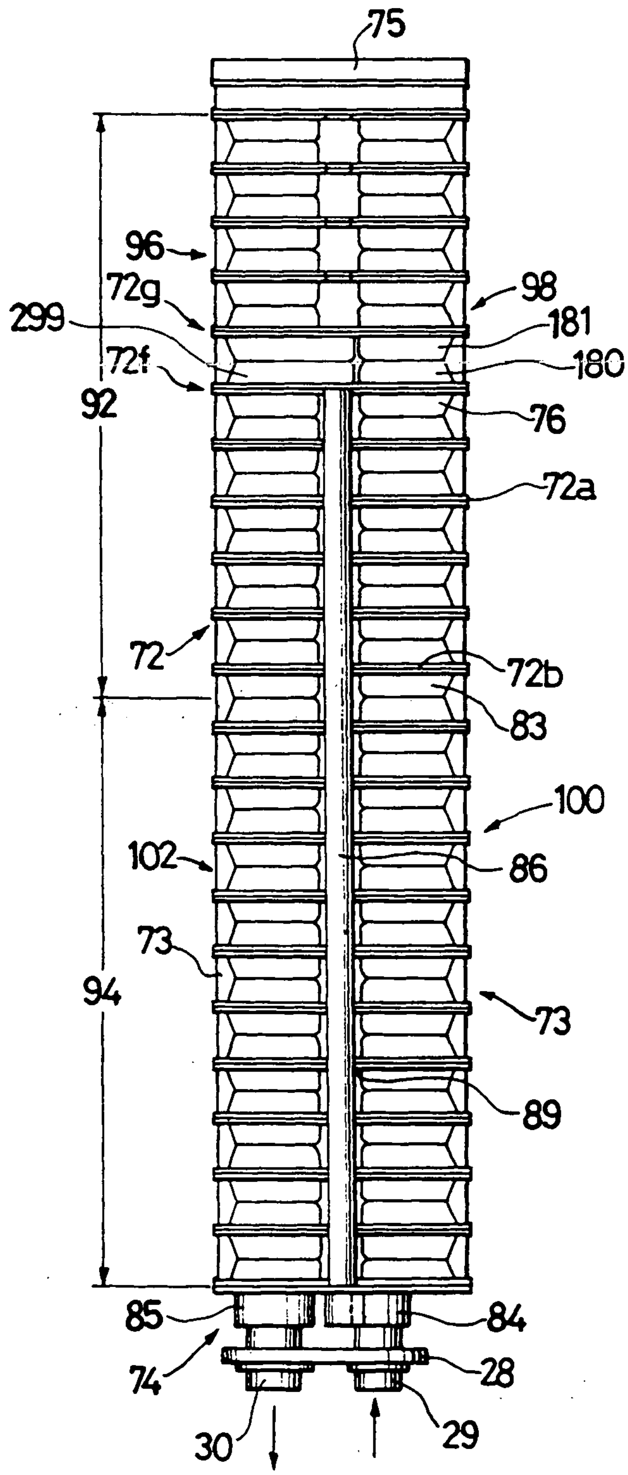
75
96
72g
299
72f
92
98
181
180
76
72a
72
72b
83
100
102
86
73
94
73
89
85
84
74
28
30
29

FIG. 21

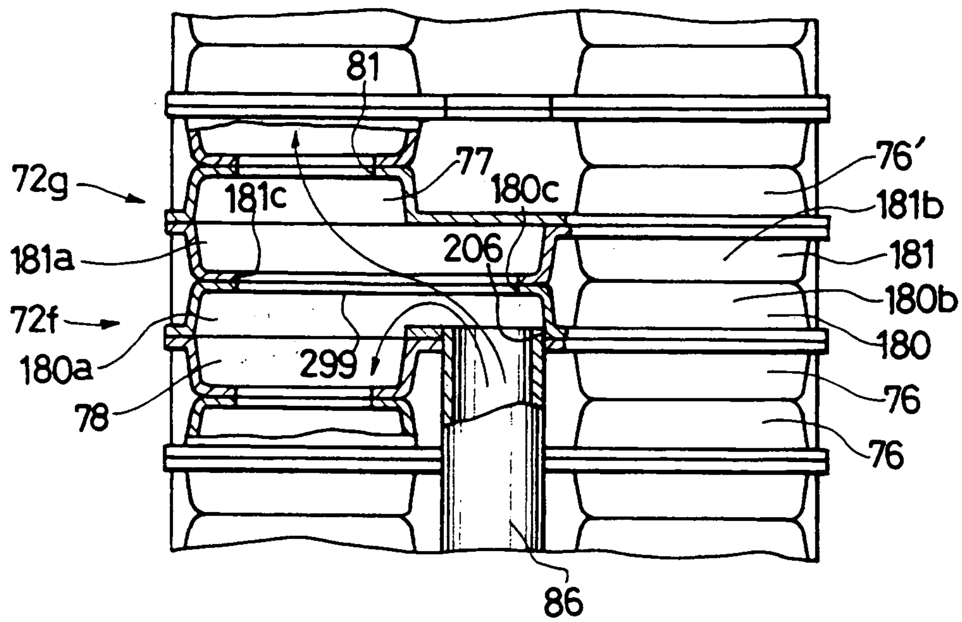
81
77
76'
72g
181c
180c
181b
181a
206
181
180b
72f
180
180a
299
76
78
76
86

FIG. 22

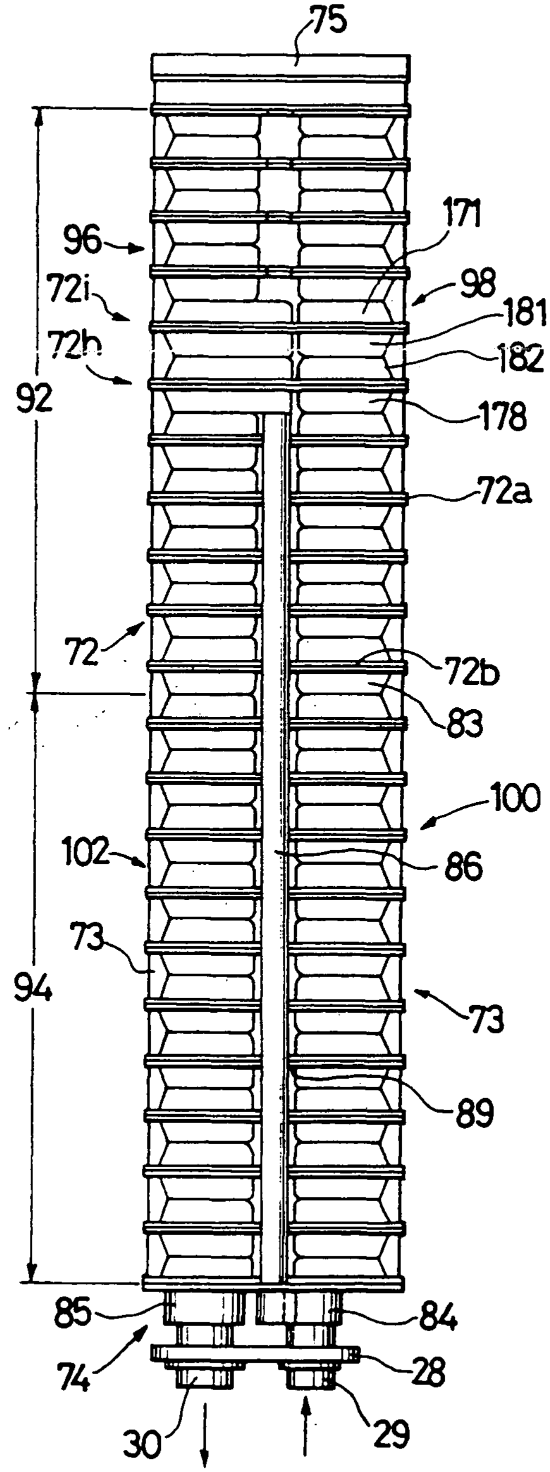
75
171
96
98
72i
181
72h
182
92
178
72a
72
72b
83
100
102
86
73
94
73
89
85
84
74
28
30
29

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FIG. 23

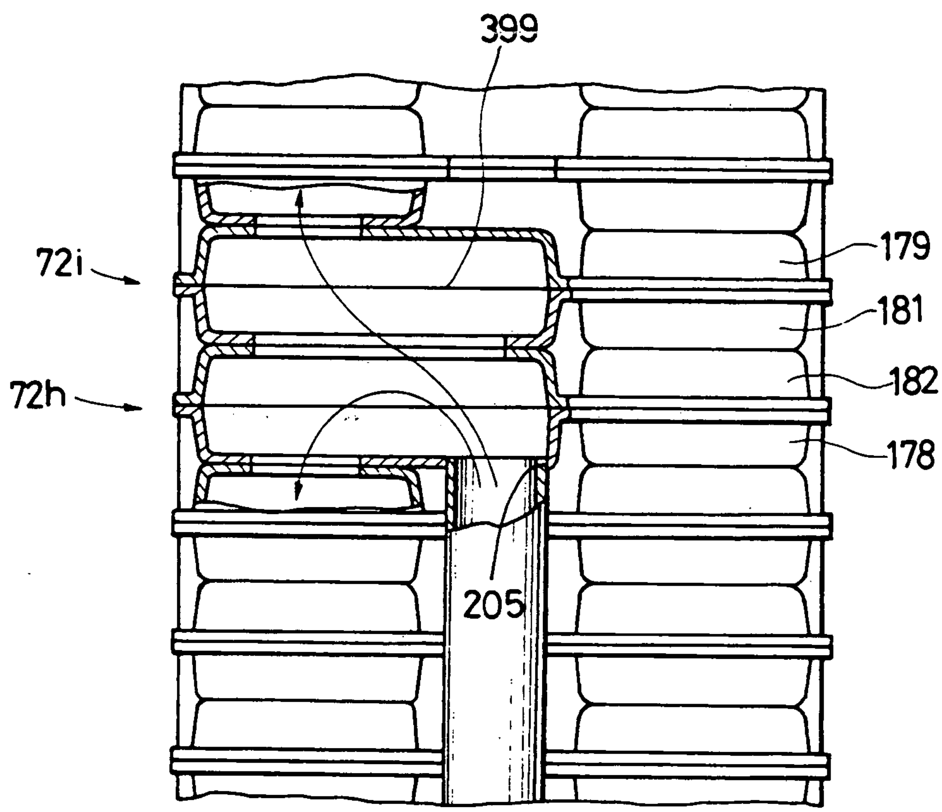

FIG. 24

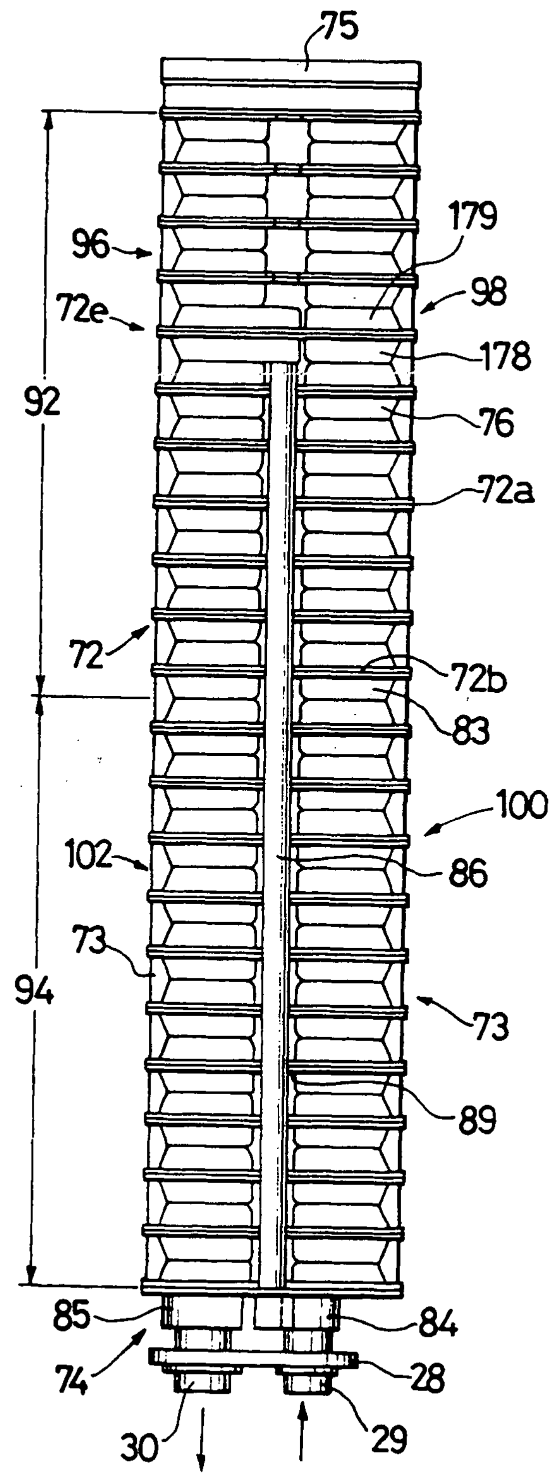
75
179
96
98
72e
178
92
76
72a
72
72b
83
100
102
86
73
94
73
89
85
84
74
28
30
29

FIG. 25

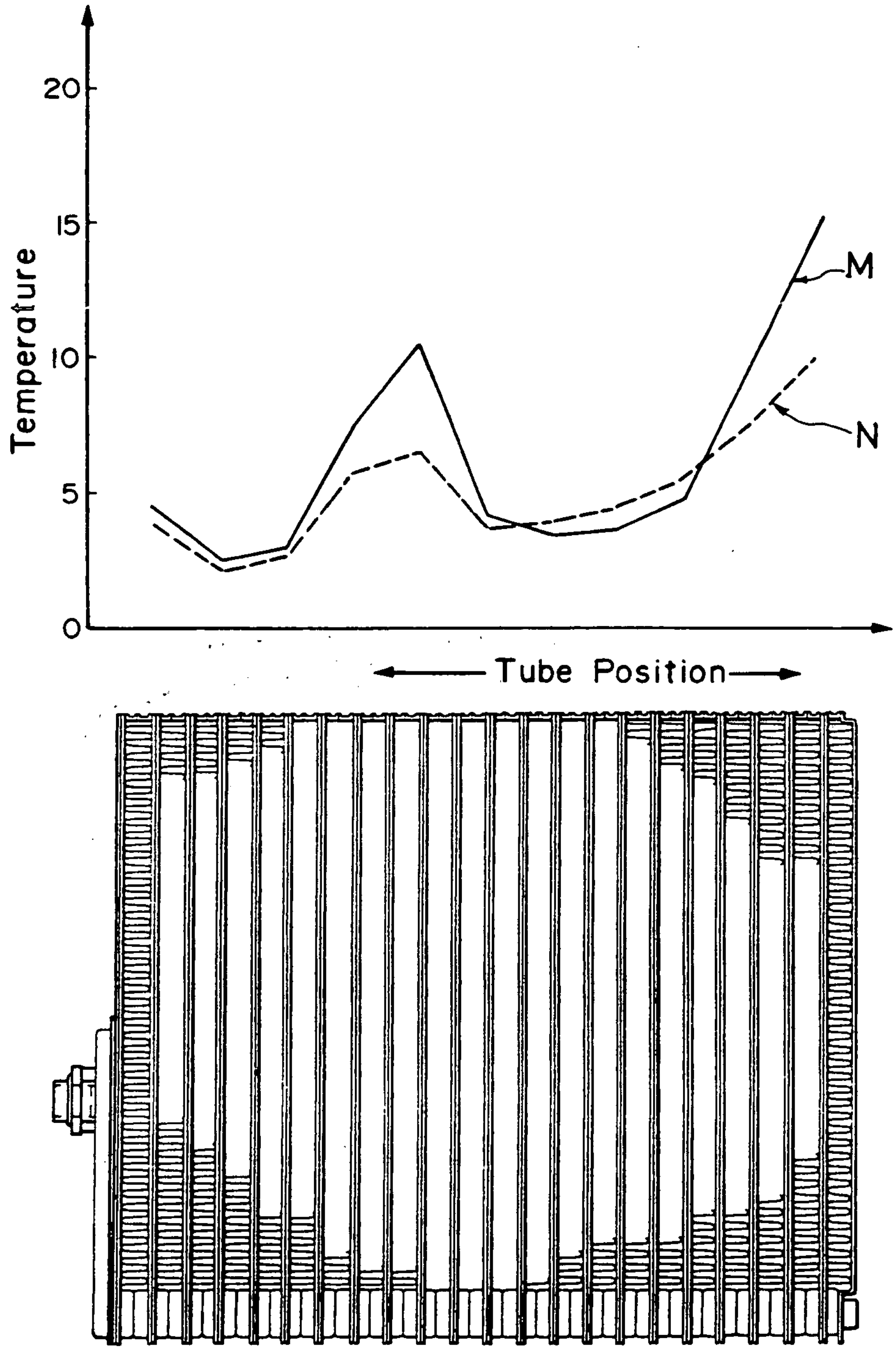

FIG. 26A

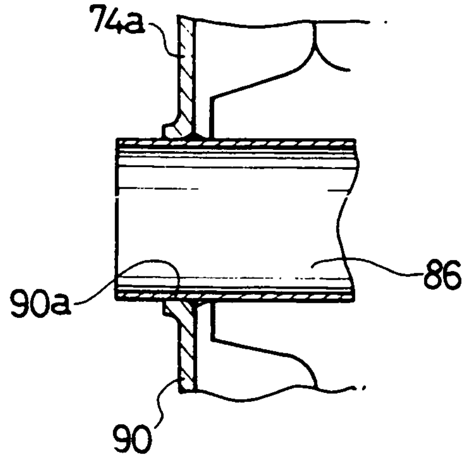

FIG. 26B

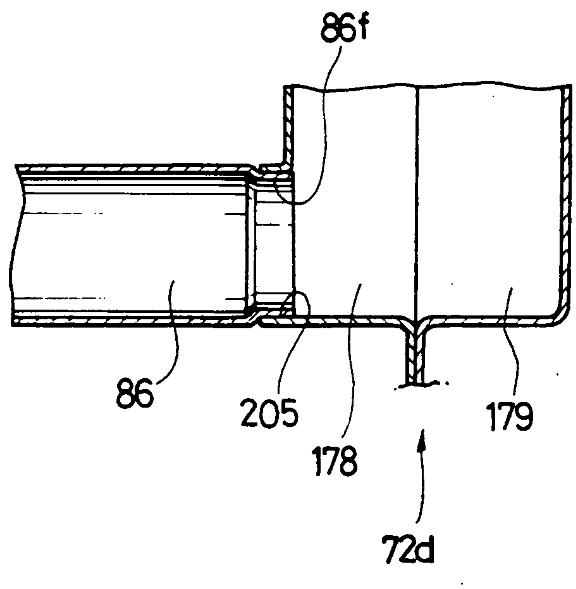

FIG. 27A

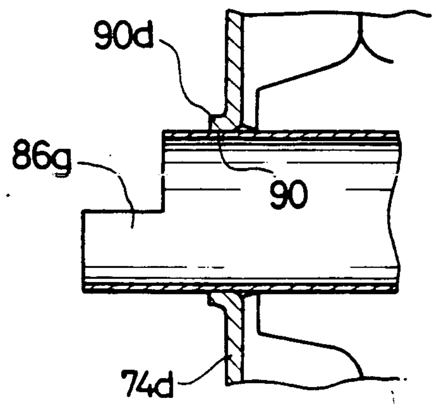

FIG. 27B